NFPA® 1960

Standard for Fire Hose Connections, Spray Nozzles, Manufacturer's Design of Fire Department Ground Ladders, Fire Hose, and Powered Rescue Tools

2024 Edition

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

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NFPA® 1960

Standard for

Fire Hose Connections, Spray Nozzles, Manufacturer's Design of Fire Department Ground Ladders, Fire Hose, and Powered Rescue Tools

2024 Edition

This edition of NFPA 1960, *Standard for Fire Hose Connections, Spray Nozzles, Manufacturer's Design of Fire Department Ground Ladders, Fire Hose, and Powered Rescue Tools*, was prepared by the Committees on Fire Hose, Fire Department Ground Ladders, and Fire Department Rescue Tools. It was issued by the Standards Council on December 1, 2023, with an effective date of December 21, 2023.

This document has been amended by one or more Tentative Interim Amendments (TIAs) and/or Errata. See "Codes & Standards" at www.nfpa.org for more information.

This edition of NFPA 1960 was approved as an American National Standard on December 21, 2023.

Origin and Development of NFPA 1960

For this first edition of NFPA 1960, *Standard for Fire Hose Connections, Spray Nozzles, Manufacturer's Design of Fire Department Ground Ladders, Fire Hose, and Powered Rescue Tools*, the legacy standards NFPA 1931, NFPA 1936, NFPA 1961, NFPA 1963, and NFPA 1964 were part of a document consolidation plan that was approved during the April 2019 Standards Council meeting that affects all documents in the Emergency Response and Responder Safety (ERRS) project. While these documents all have been consolidated into NFPA 1960, the individual committees are still responsible for the content of this consolidated standard. Meaning, the Technical Committee on Ground Ladders retains responsibility for the content that was NFPA 1931, the Technical Committee on Fire Department Rescue Tools retains responsibility for the content that was NFPA 1936, and the Technical Committee on Fire Hose retains responsibility for the content that was NFPA 1961, 1963, and 1964.

Many of the changes made for this edition are related to the consolidation of the legacy documents into NFPA 1960. In addition to those changes, there have been several changes made by each of the committees. The changes made to the ground ladder content are mostly editorial in nature. The most significant change for the rescue tool content is the addition of a new chapter on struts. This addition comes after many years of work from the fire department rescue tool committee and covers a wide range of requirements for struts, such as design requirements, performance requirements, and product labeling requirements. The changes relative to fire hose, spray nozzles, and appliances include requirements on 6 in. (152 mm) hose and 6 in. (152 mm) Storz connections given their recent increase in use in the fire service. The committee also updated some of the requirements on the basic spray nozzle tolerance's due to lower flow rate capabilities for spray nozzles.

For more information about the ERRS consolidation project, see nfpa.org/errs.

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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.

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

Chapter 1 Administration

1.1 Scope. This standard defines the performance and requirements for new fire hose couplings and adapters with nominal sizes from ¾ in. (19 mm) through 8 in. (200 mm) and the specifications for the screw thread connections on those couplings and adapters. This standard specifies the requirements for new adjustable-pattern spray nozzles intended for general firefighting use; for marine and offshore platform firefighting 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. This standard also specifies the requirements for the design of fire department ground ladders and the design verification tests to be conducted by the ground ladder manufacturer; the design and construction requirements for new fire hose and the testing to verify the design and construction as well as the inspection and testing of all new fire hose; the minimum requirements for the design, performance, testing, and product conformance verification of powered rescue tools and components; the requirements for spreader, ram, cutter, and combination powered rescue tools; and the requirements for cable assemblies, hose assemblies, and power unit components for powered rescue tools. This standard does not specify requirements for any accessories for powered rescue tools or components.

1.2 Purpose. The purpose of this standard is to specify minimum requirements for the following:

(1) Fire hose connections
(2) Spray nozzles and appliances
(3) Manufacturer's design of fire department ground ladders
(4) Fire hose
(5) Rescue tools

1.3* Application. This standard can be applied as follows:

(1) Chapters 1 through 8 and Annexes A, B, and C, constitute NFPA 1963.
(2) Chapters 1 through 3, and 9 through 12, and Annexes A and C constitute NFPA 1964.
(3) Chapters 1 through 3, and 13 through 16, and Annexes A and C constitute NFPA 1931.
(4) Chapters 1 through 3, and 17 through 20, and Annexes A and C constitute NFPA 1961.
(5) Chapters 1 through 3, and 21 through 24, and Annexes A and C constitute NFPA 1936.

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 30, *Flammable and Combustible Liquids Code,* 2024 edition.

NFPA 1932, *Standard on Use, Maintenance, and Service Testing of In-Service Fire Department Ground Ladders,* 2020 edition.

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,* 2019 edition.

NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting,* 2018 edition.

2.3 Other Publications.

2.3.1 ALI Publications. American Ladder Institute, 330 North Wabash Avenue, Suite 2000, Chicago, IL 60611.

ANSI-ASC A14.1, *American National Standard for Ladders — Wood Safety Requirements*, 2007.

ANSI-ASC A14.2, *American National Standard for Ladders — Portable Metal — Safety Requirements*, 2017.

ANSI-ASC A14.5, *American National Standard for Ladders — Portable Reinforced Plastic — Safety Requirements*, 2017.

ANSI-ASC A14.8, *American National Standard for Ladders — Safety Requirements for Ladder Accessories*, 2013.

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

ANSI S12.36, *Standard Survey Methods for the Determination of Sound Pressure Levels of Noise Sources*, 1990, revised 1997.

2.3.3 ASME Publications. ASME International, Two Park Avenue, New York, NY 10016-5990.

ASME B1.2, *Gages and Gaging for Unified Inch Screw Threads*, 83rd edition, 1991, reaffirmed 2007.

ASME B40.100, *Pressure Gauges and Gauge Attachments*, 2013.

2.3.4 ASQ Publications. American Society for Quality, 600 North Plankinton Avenue, Milwaukee, WI 53203.

ASQ Z1.4, *Sampling Procedures and Tables for Inspection by Attributes*, 2003, reapproved 2013.

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

ASTM B30, *Standard Specification for Copper Alloys in Ingot Form*, 2016.

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

ASTM B584, *Standard Specification for Copper Alloy Sand Castings for General Applications*, 2014.

ASTM D380, *Standard Test Methods for Rubber Hose*, 1994, reapproved 2012.

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*, 2004, reapproved 2015.

ASTM D1149, *Standard Test Methods for Rubber Deterioration — Cracking in an Ozone Controlled Environment*, 2007, reapproved 2012.

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

ASTM D3183, *Standard Practice for Rubber — Preparation of Pieces for Test Purposes from Products*, 2010, reapproved 2015.

2.3.6 CENELEC Publications. European Committee for Electrotechnical Standardization, CEN-CENELEC Management Centre, Avenue Marnix 17, 4th Floor, B - 1000 Brussels.

EN 837-1, *Standard Bourdon Tube Pressure Gauges*, 2016.

EN 837-2, *Pressure Gauges — Part 2: Selection and Installation Recommendations for Pressure Gauges*, 1998.

EN 837-3, *Pressure Gauges — Part 3: Diaphragm and Capsule Pressure Gauges — Dimensions, Metrology, Requirements and Testing*, 1998.

2.3.7 FM Publications. FM Global, 270 Central Avenue, P.O. Box 7500, Johnston, RI 02919-4923.

FM Approval 2111, *Factory Mutual Approval Standard for Fire Hose*, 2014.

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

ISO 2503, *Gas welding equipment — Pressure regulators for gas cylinders used in welding, cutting and allied processes up to 300 bar*, 2009.

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

ISO/IEC 17011, *General requirements for accreditation bodies accrediting conformity assessment bodies*, 2004.

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*, 2005.

ISO/IEC 17065, *Conformity assessment — Requirements for bodies certifying products, processes and services*, 2012.

2.3.9 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062.

ANSI/UL 19, *Lined Fire Hose and Hose Assemblies*, 14th edition, 2018.

ANSI/UL 92, *Fire Extinguisher and Booster Hose*, 10th edition, July 2, 2008.

ANSI/UL 219, *Lined Fire Hose for Interior Standpipes*, 2013.

UL 252, *Standard for Safety Compressed Gas Regulators*, 2017.

UL 969, *Standard for Marking and Labeling Systems*, 1995, revised 2014.

ANSI/UL 969A, *Standard for Marking and Labeling Systems — Flag Labels, Flag Tags, Wrap-Around Labels, and Related Products*, 2020.

UL 60745-1, *Standard for Hand-Held Motor-Operated Electric Tools — Safety — Part 1: General Requirements*, 2013.

2.3.10 USDA Publications. USDA Forest Service, San Dimas Technology and Development Center, 444 East Bonita Avenue, San Dimas, CA 91773-3198.

USDA Specification 5100-186d, *Forest Service Specification for Fire Hose, Cotton-Synthetic, Lined, Woven Jacket, 1 inch and 1½ inch*, May 2006.

USDA Specification 5100-187c, *Forest Service Specification for Fire Hose, Lightweight Synthetic, Lined, Woven Jacket*, March 2006.

2.3.11 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2019 edition.

NFPA 1900, *Standard for Aircraft Rescue and Firefighting Vehicles, Automotive Fire Apparatus, Wildland Fire Apparatus, and Automotive Ambulances*, 2024 edition.

NFPA 1962, *Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances*, 2018 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 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

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

3.2.5 Shall. Indicates a mandatory requirement.

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

3.2.7 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 phrases "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.

3.3.1 Accessories. Those items that are attached to the powered rescue tool or to a component thereof, but are not necessary for the rescue tool or component to meet the requirements of this standard.

3.3.2 Adapter. Any device that allows fire hose couplings to be safely interconnected with couplings of different sizes, threads, or mating surfaces, or that allows fire hose couplings to be safely connected to other appliances.

3.3.2.1 ***Nonthreaded Coupling or Adapter.*** A coupling or adapter in which the mating is achieved with locks or cams but without the use of screw threads.

3.3.2.2 ***Screw Thread Coupling or Adapter.*** A coupling or adapter in which the mating is achieved with the use of threads.

3.3.3 Angle of Inclination. The angle incorporated between the beams and a level plane.

3.3.4 Attic Extension Ladder. An extension ladder that is specifically designed to be used to gain entry through a scuttle, hatch, or other similarly restricted opening.

3.3.5 Bark Pocket. See 3.3.113.1, Bark Pocket Wood Irregularity.

3.3.6 Base (Bed) Section. The lowest or widest section of an extension ladder.

3.3.7 Beam (Side Rail). The main structural side of the ground ladder.

3.3.8 Bedded Position. The position in which the fly section(s) of an extension ladder is fully retracted with the pawls engaged.

3.3.9 Blunt Start. The removal of the incomplete thread at the end of the thread. This is a feature of threaded parts that are repeatedly assembled by hand. Also known as the "Higbee cut."

3.3.10 Bowl Gasket. See 3.3.43.1.

3.3.11 Break-Apart Monitor. See 3.3.62.1.

3.3.12* Butt. The end of the beam that is placed on the ground, or other lower support surface, when ground ladders are in the raised position.

3.3.13* Butt Spurs (Feet). That component of ground ladder support that is in contact with the lower support surface to reduce slippage.

3.3.14 Certification. A system whereby a third-party certification organization determines that a manufacturer has demonstrated the ability to produce a product that complies with the requirements of this standard, authorizes the manufacturer to use a label on listed products that comply with the requirements of this standard, and establishes a follow-up program conducted by the third-party certification organization as a check on the methods the manufacturer uses to determine continued compliance of labeled and listed products with the requirements of this standard.

3.3.15 Check. See 3.3.113.2, Check Wood Irregularity.

3.3.16 Coating. A protective material impregnated, saturated, or coated on the outside reinforcement layer of the hose to provide additional reinforcement or protection for the hose.

3.3.17 Collapsible Ladder. See 3.3.40, Folding Ladder.

3.3.18 Combination Ladder. A ground ladder that is capable of being used both as a stepladder and as a single or extension ladder.

3.3.19 Compliant. Verified as meeting or exceeding all applicable requirements of this standard.

3.3.20 Continual. With respect to the testing of a powered rescue tool, a test sequence performed with pauses or interruptions.

3.3.21 Continuous. With respect to the testing of a powered rescue tool, a test sequence performed without any pauses or interruptions for any purpose.

3.3.22 Control.

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

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

3.3.22.3 ***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.

3.3.23 Coupling Assembly. A complete coupling including its gaskets and the expansion rings or collar pieces used in attaching the coupling to the hose.

3.3.24 Couplings. One set or pair of connection devices attached to a fire hose that allow the hose to be interconnected to additional lengths of hose or adapters and other firefighting appliances.

3.3.25 Cover. An additional layer on the outside of a hose consisting of a continuous synthetic rubber or plastic that is usually thicker than a coating.

3.3.26 Creep. Unintended movement.

3.3.27 Cycle. See 3.4.6, Operational Cycle.

3.3.28 Deadman Control. A device designed to automatically return the operational controls to the neutral position in the event that the operational control is released.

3.3.29* Design Verification Tests. Tests of a ladder structure and components thereof that are performed by the ladder manufacturer to prove conformance to design requirements and which can potentially compromise the integrity of the tested ladder.

3.3.30 Designated Length. The length marked on the ladder.

3.3.31 Duty Rating. The maximum load the ladder is designed to support when it is in use and properly positioned.

3.3.32 Elongation. The percent a section of hose increases in length from an initial measurement with the hose pressurized at 10 psi (6.9 kPa) to a final measurement with the hose pressurized at its proof test pressure.

3.3.33 Extension Ladder. A non-self-supporting ground ladder that consists of two or more sections traveling in guides, brackets, or the equivalent arranged so as to allow length adjustment.

3.3.34 Face Gasket. See 3.3.43.2.

3.3.35 Fire Department Connection. A connection through which the fire department can pump supplemental water into the sprinkler system, standpipe, or other water-based fire protection systems, thereby supplementing existing water supplies. [**24,** 2019]

3.3.36 Fire Department Ground Ladder. Any portable ladder specifically designed for fire department use in rescue, firefighting operations, or training.

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

3.3.38* 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.

3.3.39 Fly Section(s). The upper section(s) of an extension ladder.

3.3.40 Folding Ladder. A single-section ladder with rungs that can be folded or moved to allow the beams to be brought into a position touching or nearly touching each other.

3.3.41 Follow-Up Program. The sampling, inspections, tests, or other measures conducted by the third-party certification organization on a periodic basis to determine the continued compliance of listed products that are being produced by the manufacturer to the requirements of this standard.

3.3.42 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.

3.3.43 Gasket.

3.3.43.1 ***Bowl Gasket.*** See 3.3.43.3, *Tail Gasket.*

3.3.43.2 ***Face Gasket.*** The water pressure seal at the mating surfaces of nonthreaded couplings or adapters.

3.3.43.3 ***Tail Gasket.*** A gasket in the bowl of a coupling used to provide a watertight seal between the coupling and the hose in an expansion ring-type coupling.

3.3.43.4 ***Thread Gasket.*** A gasket used in a female threaded connection to provide a watertight seal between the male and female threaded connections.

3.3.44 Halyard. Rope used on extension ladders for the purpose of raising a fly section(s).

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

3.3.46 Heat Sensor Label. A label that changes color at a preset temperature to indicate a specific heat exposure.

3.3.47 Hose.

3.3.47.1* ***Attack Hose.*** Hose designed to be used by trained firefighters and fire brigade members to combat fires beyond the incipient stage.

3.3.47.2 ***Booster Hose.*** A noncollapsible hose used under positive pressure having an elastomeric or thermoplastic tube, a braided or spiraled reinforcement, and an outer protective cover. [**1962,** 2018]

3.3.47.3 ***Fire Hose.*** A flexible conduit used to convey water.

3.3.47.4 ***Forestry Fire Hose.*** A hose designed to meet specialized requirements for fighting wildland fires.

3.3.47.5 ***Large-Diameter Hose.*** A hose of 3½ in. (90 mm) or larger size.

3.3.47.6 ***Occupant Use Hose.*** Fire hose designed to be used by the building's occupants to fight incipient fires prior to the arrival of trained firefighters or fire brigade members.

3.3.47.7 ***Suction Hose.*** A hose that is designed to prevent collapse under vacuum conditions so that it can be used for drafting water from below the pump (lakes, rivers, wells, etc.).

3.3.47.8* ***Supply Hose.*** Hose designed for the purpose of moving water between a pressurized water source and a pump that is supplying attack lines.

3.3.48 Hose Assembly. Hose with couplings attached to both ends.

3.3.49 Hose Size. An expression of the internal diameter of the hose.

3.3.50 Identical Rescue Tools. Powered rescue tools that are produced to the same engineering and manufacturing specifications.

3.3.51 Jacket. See 3.3.78, Reinforcement.

3.3.52 Knot. See 3.3.113.3, Knot Wood Irregularity.

3.3.53 Ladder. A device consisting of two beams (side rails) joined at regular intervals by cross pieces called rungs on which a person is supported during climbs for ascending or descending. *(See also 3.3.70, Pompier Ladder.)*

3.3.54 Ladder Accessory. A device that — when installed or attached to a ladder — expands the ladder's function, utility, and safety, but is not essential for the ladder's intended function.

3.3.55 Ladder Nesting. The procedure whereby ladders of different sizes are positioned partially within one another to reduce the amount of space required for their storage on the apparatus.

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

3.3.57 Large-Stream Device. Any device that discharges water at a flow rate greater than 400 gpm (1600 L/min).

3.3.58 Manufacturer. The entity that assembles the compliant product and also maintains the certification.

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

3.3.60 Maximum Extended Length. The total length of the extension ladder when all fly sections are fully extended and all pawls are engaged.

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

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

3.3.62.1 ***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.

3.3.62.2 ***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.

3.3.63* Multipurpose Ladder. A ground ladder capable of being used as either a step ladder or a straight ladder and comprising two telescoping adjustable-length-section assemblies connected via a hinge assembly.

3.3.64 NH. An American National Fire Hose Connection Screw Thread. *(See Section 5.2.)*

3.3.65 Nonthreaded Coupling or Adapter. See 3.3.2.1.

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

3.3.66.1 ***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.

3.3.66.2 ***Straight Tip Nozzle.*** A smooth-bore nozzle for producing a solid stream.

3.3.67 Pawls. Devices attached to a fly section(s) to engage ladder rungs near the beams of the section below for the purpose of anchoring the fly section(s); also referred to as "dogs."

3.3.68 Permanent Deformation. That deformation remaining in any part of a ladder or its components after all test loads have been removed from the ladder.

3.3.69 Pitch Pocket. See 3.3.113.4, Pitch Pocket Wood Irregularity.

3.3.70 Pompier Ladder (Scaling Ladder). A ladder having a single center beam only with rungs protruding on either side of the beam and with a large hook on top that is used for scaling.

3.3.71 Portable Monitor. See 3.3.63.2.

3.3.72 Portable Valve. See 3.3.108.1.

3.3.73 Pressure.

3.3.73.1 ***Burst Test Pressure.*** A pressure equal to at least three times the service test pressure.

3.3.73.2 ***Design Service Test Pressure.*** The hydrostatic service test pressure as designated by the fire hose manufacturer.

3.3.73.3 ***High Pressure.*** Pump discharge pressure from 500 psi (3500 kPa) to less than 1100 psi (7600 kPa). [**1900,** 2024]

3.3.73.4 ***Kink Test Pressure.*** A pressure equal to at least 1.5 times the service test pressure.

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

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

3.3.73.7 ***Operating Pressure.*** The highest pressure the hose should be used to in regular operation.

3.3.73.8 ***Proof Test Pressure.*** A pressure equal to at least two times the service test pressure.

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

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

3.3.73.10 ***Service Test Pressure.*** The hydrostatic test pressure marked on the hose that determines the pressure that the hose is service tested to as required by NFPA 1962.

3.3.73.11 ***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).

3.3.74 Primary Inlet. The inlet where an appliance connects to a hose.

3.3.75* Product Label. A label or marking affixed to powered rescue tools and components thereof by the manufacturer containing general information, care, maintenance, or similar data.

3.3.76 Pulley. A device attached to a ladder section, consisting of a wheel(s) over which a rope or cable runs for the purpose of changing direction while extending or lowering an extension ladder.

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

3.3.78* Reinforcement. The structural support for fire hose that is often in the form of woven yarn.

3.3.79 Rescue Tool. Another term for powered rescue tool.

3.3.80 Rescue Tool Components. See 3.4.9, Powered Rescue Tool Components.

3.3.81 Rise. The maximum distance measured from the surface of a test table to the underside of the hose that a length of hose lifts off that table when it is pressurized at its proof test pressure.

3.3.82 Roof Ladder. A single ladder equipped with hooks at the top end of the ladder.

3.3.82.1 ***Double-Ended Roof Ladder.*** Roof ladder with hooks at both ends and spurs on at least one end.

3.3.83 Rungs. The ladder cross pieces on which a person steps while ascending or descending.

3.3.84 Scaling Ladder. See 3.3.70, Pompier Ladder.

3.3.85 Screw Thread Coupling or Adapter. See 3.3.2.2.

3.3.86 Shutoff Valve. See 3.3.108.2.

3.3.87 Side Rail. See 3.3.7, Beam.

3.3.88 Single Ladder. A non-self-supporting ground ladder, nonadjustable in length, consisting of only one section.

3.3.89 Slope of Grain. See 3.3.113.5, Slope of Grain Wood Irregularities.

3.3.90 Slow-Operating Valve. See 3.3.108.3.

3.3.91 Split. See 3.3.113.6, Split Wood Irregularity.

3.3.92 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.

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

3.3.92.2* ***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.

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

3.3.92.4* ***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.

3.3.93 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.

3.3.94 Staypoles (Tormentors). Poles attached to each beam of the base section of extension ladders and used to assist in raising the ladder and to help provide stability of the raised ladder.

3.3.95 Straight Tip Nozzle. See 3.3.67.2.

3.3.96 Suction Hose. A hose that is designed to prevent collapse under vacuum conditions so that it can be used for drafting water from below the pump (lakes, rivers, wells, etc.).

3.3.97 System Input. The input pressure or electrical power that the powered rescue tool is subjected to at any given moment.

3.3.98 Tail Gasket. See 3.3.43.3.

3.3.99 Third-Party Certification Organization. An independent third-party certification organization that determines product compliance with the requirements of this standard with a labeling/listing/follow-up program.

3.3.100 Thread.

3.3.100.1 ***Warp Thread.*** The threads or yarns of a hose reinforcement that run lengthwise to the hose.

3.3.100.2 ***Weft Thread.*** The threads or yarns of a hose reinforcement that are helically wound throughout the length of the hose at approximately right angles to the warp threads.

3.3.101 Thread Gasket. See 3.3.43.4.

3.3.102 Tip. The end of the ladder opposite the butt end.

3.3.103 Tool. Another term for powered rescue tool.

3.3.104 Tormentors or Tormentor Poles. See 3.3.94, Staypoles.

3.3.105 Trade Size. The following are considered the trade sizes of fire hose: 1, 1½, 1¾, 2, 2¼, 2½, 2¾, 3, 3½, 4, 4½ 5, and 6 in. (25, 32, 44, 51, 57, 64, 70, 76, 89, 102, 114, 127, and 152 mm).

3.3.106 Twist. The number of revolutions the free end of a 50 ft (15 m) length of hose rotates when it is pressurized from

an initial pressure at 10 psi (6.9 kPa) to its proof test pressure with one end held stationary and the other end allowed to move freely.

3.3.107 Ultimate Failure. Collapse of a ground ladder structure or component thereof.

3.3.108 Valve.

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

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

3.3.108.3 ***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. [**1900,** 2024]

3.3.109 Vendor Confirmation. A written statement by the original manufacturer of a component that states the specification or performance range, or both, of the component.

3.3.110 Visible Damage. A permanent change in condition that is clearly evident by visual inspection without recourse to optical measuring or observation devices.

3.3.111 Visual Inspection. Observation by eye unaided by optical devices, except prescription eyeglasses or lenses.

3.3.112 Warp. The maximum distance any portion of a hose deviates from a straight line running from the center of the fitting at one end to a point on the center of the hose 50 ft (15 m) from that fitting, with the hose pressurized at its proof test pressure.

3.3.113 Wood Irregularities. Natural characteristics in or on the wood that can lower its durability, strength, or utility.

3.3.113.1* ***Bark Pocket Wood Irregularity.*** An opening between annual growth rings that contains bark.

3.3.113.2 ***Check Wood Irregularity.*** A separation of the wood along the fiber direction that usually extends across the rings of annual growth and commonly results from stresses set up in the wood during seasoning.

3.3.113.3* ***Knot Wood Irregularity.*** A portion of a branch or limb embedded in the tree and cut during the process of lumber manufacture.

3.3.113.4 ***Pitch Pocket Wood Irregularity.*** An opening extending parallel to the annual growth rings that contains, or that has contained, either solid or liquid pitch.

3.3.113.5* ***Slope of Grain Wood Irregularities.*** A deviation of the fiber direction from a line parallel to the sides of the piece.

3.3.113.6 ***Split Wood Irregularity.*** A separation of the wood parallel to the fiber direction due to tearing of the wood fibers.

3.4 Powered Rescue Tools Definitions.

3.4.1 Cable Assembly. A powered rescue tool component consisting of the power cable with all permanently attached connectors that connect the powered rescue tool to the power unit.

3.4.2 Combination Tool. A powered rescue tool capable of, at a minimum, spreading and cutting.

3.4.3 Cutter. A powered rescue tool with at least one movable blade used to cut, shear, or sever material.

3.4.4 Dump Valve. A device on a power unit to redirect all of the system flow to the reservoir.

3.4.5 Hose Assembly. A powered rescue tool component consisting of hose with all permanently attached fittings that connect the powered rescue tool to the power unit.

3.4.6 Operational Cycle. The movement of the powered rescue tool from the fully closed or retracted position to the fully open or extended position and returned to the fully closed or retracted position.

3.4.7 Power Unit. A powered rescue tool component consisting of a prime mover and the principal power output device used to power the rescue tool.

3.4.8 Powered Rescue Tool. A rescue tool that receives power from the power unit component and generates the output forces or energy used to perform one or more of the functions of spreading, lifting, holding, crushing, pulling, or cutting.

3.4.9* Powered Rescue Tool Components. Components such as cable assemblies, hose assemblies, power units, hose reels, and remote valve blocks.

3.4.10 Prime Mover. Part of the power unit component and the energy source that drives the principal power output device of the power unit.

3.4.11 Pulling Force. The force to pull generated by a powered rescue tool and measured or calculated at the standard production pulling attachment points on the tool.

3.4.11.1 ***Highest Pulling Force (HPF).*** The pulling force achieved by the powered rescue tool while operating at the rated system input at the position of the arms or piston where the tool generates its greatest amount of force.

3.4.11.2 ***Lowest Pulling Force (LPF).*** The pulling force achieved by the powered rescue tool while operating at the rated system input at the position of the arms or piston where the tool generates its least amount of force.

3.4.12 Ram. A powered rescue tool that has an extender that generates extending forces or both extending and retracting forces.

3.4.13 Rated System Input. The maximum input pressure/electrical power at which the powered rescue tool is designed to operate.

3.4.14 Spreader. A powered rescue tool that has at least one movable arm that opens to move material.

3.4.15 Spreading Force. The force to push or pull generated by a spreader rescue tool and measured or calculated at the very tips of the spreader arms or ram.

3.4.15.1 ***Highest Spreading Force (HSF).*** The spreading force achieved by the powered rescue tool while operating at the rated system input at the position of the arms or piston where the tool generates its greatest amount of force.

3.4.15.2 ***Lowest Spreading Force (LSF).*** The spreading force achieved by the powered rescue tool while operating at the

rated system input at the position of the arms or piston where the tool generates its least amount of force.

3.5 Lifting Bags Definitions.

3.5.1 Allowable Pressure (AP). The maximum operating pressure for each component of the system stated in bar and psi.

3.5.2 Components. See 3.5.10.2, Lifting Bag Components.

3.5.3 Control Device. A lifting bag system component that controls the inflation and deflation of a lifting bag.

3.5.4 Couplings. Connectors attached to the hose assemblies, lifting bags, or accessories to allow for the connection and disconnection of components. *(See also 3.3.24.)*

3.5.4.1 ***Quick-Action Couplings.*** Couplings designed for quick connection and disconnection.

3.5.5 Hose Assembly. A hose complete with attached quick-action coupler(s) with or without fittings.

3.5.6 Identical Lifting Bags. Lifting bags produced to the same engineering and manufacturing specifications.

3.5.7 Inflation Height. The sum of the insertion height and the inflated proportion of a bag's maximum inflation height.

3.5.8 Inlet Connection. A fitting incorporated into a lifting bag in such a way that it is not readily removable, to which a quick-action coupling is connected.

3.5.9 Insertion Height. The smallest opening into which a deflated bag can be inserted.

3.5.10 Lifting Bag System. The combination of components, excluding the air source, that, when assembled, can inflate or deflate a lifting bag using compressed air from an operator-controlled air source.

3.5.10.1 ***Lifting Bag.*** A portable inflatable bag used to apply force to move or lift objects.

3.5.10.2 ***Lifting Bag Components.*** Components such as a hose and hose assembly, regulator, pressure indicator, safety valve, and a control device.

3.5.11 Lifting Capacity. The maximum load a lifting bag can lift at allowable pressure.

3.5.12 Loss of Integrity. Damage caused by leakage, delaminating, or unexpected deformation.

3.5.13 Maximum Lifting Height. The sum of the insertion height and stroke of the lifting bag.

3.5.14 Operational Cycle. The movement of the lifting bag from the fully deflated position to the fully inflated position and then returned to the fully deflated position.

3.5.15 Preset Regulator. A regulator set before incorporation into a lifting bag system to a defined pressure level and not intended to be easily adjusted by the user.

3.5.16 Pressure Indicator. A device that measures and visually displays pressure.

3.5.17 Regulator. A device for regulating a generally variable inlet pressure to as constant as possible outlet pressure.

3.5.18 Stroke. The distance from the insertion height to the maximum inflated position at allowable pressure without a load applied.

3.5.19 System Input. The input pressure a lifting bag is subjected to at any given moment.

3.5.20 Volume. Geometric internal volume of a lifting bag when inflated to allowable pressure without load.

3.6 Strut Definitions.

3.6.1 Base. A component of a strut used to support the load at a contact point over a larger area.

3.6.1.1 ***Removable Base.*** A base intended to remove or add to a strut and which can be replaced by another configuration.

3.6.1.2* ***Universal Base.*** A base designed for testing purposes only.

3.6.2 Built-In Automatic Safety Relief Device. A device that releases pressure inside the hydraulic strut to prevent overpressurization in the case of a blocked return line of a double-acting strut.

3.6.3 Check Valves. One-way direction valve that allows flow in one direction only.

3.6.4 Extension Area. Piston area (mostly opposite to rod side) that, when pressurized, results in extension (i.e., lifting) force.

3.6.5 Failure Load. Load where the strut will break, collapse, or buckle.

3.6.6 Force.

3.6.6.1 ***Highest Lifting Force (HLF).*** The highest recorded lifting force.

3.6.6.2 ***Lowest Lifting Force (LLF).*** The lowest recorded lifting force.

3.6.7 Locking Mechanism. A mechanical load stop that only can be released when actuated by the operator.

3.6.8 Operating Control. Device intended to control the tool.

3.6.9 Operational Cycle. A strut moving from the fully retracted position to the fully extended position and returning to the fully retracted position.

3.6.10 Overpressurization. A condition in which the pressure exceeds the rated input.

3.6.11 Quick-Connect Couplers. A coupler intended to connect and disconnect hoses (without tools).

3.6.12 Rated System Input. The maximum input at which the strut is designed to operate.

3.6.13 Retract Area. Piston area (mostly rod side) that, when pressurized, results in retracting force.

3.6.14 Safety Factor. The multiplier to WLL within which no failure (i.e., break or buckling) occurs.

3.6.15 Strut. A systematic set of components that can be mechanically locked and intended for temporary (structural) support.

3.6.15.1 ***Double-Acting Strut.*** A strut that can be expanded or contracted axially with an electric, pneumatic, or hydraulic power assist.

3.6.15.2 ***Mechanical Lifting Strut.*** A strut that can apply a force when actuated manually and is intended to lift.

3.6.15.3 ***Powered Lifting Strut.*** A lifting strut actuated by a source other than manual input.

3.6.15.4 ***Stabilization Strut.*** Strut intended to support the load position (i.e., not to lift or lower the load).

3.6.15.5* ***Strut Accessory.*** Any part of the strut supplementary to its function.

3.6.15.6* ***Strut Component.*** Integral parts of the strut required for its function.

3.6.15.7* ***Strut Extension.*** A fixed length, rigid device for temporary (or structural) support.

3.6.16* Tip. A component of a strut used to support the load at a contact point over a smaller area.

3.6.17 Universal Base End. A base for attachment to a strut that allows for 360 degrees of rotation.

3.6.18 Working Load Limit (WLL). Working load limit is the failure load divided by the safety factor (2:1).

Chapter 4 General Coupling and Adapter Requirements (NFPA 1963)

4.1 Administration.

4.1.1* Scope.

4.1.1.1 Chapters 4 through 8 give the performance and requirements for new fire hose couplings and adapters with nominal sizes from ¾ in. (19 mm) through 8 in. (200 mm) and the specifications for the screw thread connections on those couplings and adapters.

4.1.1.2 Chapters 4 through 8 also give the performance and requirements for the mating surfaces of nonthreaded fire hose couplings and adapters with nominal sizes of 4 in. (100 mm) and 5 in. (125 mm).

4.1.2 Purpose. The purpose of this standard is to provide a uniform standard for safe couplings and adapters for the users of fire hose connections.

4.1.3 Application.

4.1.3.1 The requirements of this standard shall apply to the following coupling and adapters in the sizes defined in Section 1.1.

(1) Fire hose couplings
(2) Booster hose couplings
(3) Suction hose couplings
(4) Adapters
(5) Reducers
(6) Caps
(7) Plugs
(8) Connections on fire hose appliances where they attach to fire hose

4.1.3.2 The requirements of this standard shall also apply to screw thread connections and nonthreaded mating surfaces on the following devices in the sizes defined in Section 1.1:

(1) Pump intake connections on fire apparatus
(2) Pump discharge connections on fire apparatus
(3) Sprinkler connections
(4) Standpipe connections
(5) Hose connections on fire hydrants
(6) Connections on all other hose fittings and appliances that attach to fire pumps, fire hose, or hydrants

4.2* Workmanship. The coupling assembly or adapter shall be made and finished in a workmanship-like manner throughout.

4.2.1 All edges shall be chamfered and free from burrs.

4.2.2 Hose bowl or tailpiece lips shall be rounded to prevent damage to the hose.

4.3 Materials. Materials used shall be free of defects that would adversely affect the performance or maintenance of individual components or of the overall assembly.

4.4 Minimum Waterway. The design of the shank-type and nonthreaded expansion ring coupling shall be such that the coupling shall not restrict the waterway by more than ¼ in. (6.4 mm) on couplings of nominal size 2½ in. (65 mm) or less and not more than ½ in. (12.7 mm) on couplings of nominal size greater than 2½ in. (65 mm). Gaskets shall not protrude into the waterway.

4.4.1 The waterway of a size-increasing-style coupling, other than a shank-type coupling, shall be no smaller than the nominal size of the hose to which it is attached.

4.4.2 The waterway of a size-reducing-style coupling, other than a shank-type coupling, shall be no smaller than the nominal size of the attachment face.

4.5 Gasket Groove. All sizes of internal NH threaded couplings, connections, or adapters shall have a standard gasket groove diameter as shown in Table 5.4.2, column *K. (See also Figure 5.1.5.1, dimension K.)*

4.6 Testing. Tests required by this standard shall be conducted by the manufacturer or by an approved testing facility designated by the manufacturer.

4.6.1 All tests shall be conducted on standard commercially available product.

4.6.2 Any test that requires the use of hose shall use hose with the highest service test pressure commercially available to which the coupling can be attached.

4.7 Internal Strength.

4.7.1 The coupling or adapter shall be capable of withstanding a hydrostatic pressure equal to the service test pressure without leakage, two times service test pressure with no leakage more severe than 12 drops per minute (½ ml per minute), and three times the service test pressure plus 100 psi (690 kPa) without separation. It shall be tested in accordance with 4.7.2 to prove compliance.

4.7.2 Internal Strength Test.

4.7.2.1 The coupling or adapter shall be plugged and adapted on one end to accept a pump connection from a hydrostatic test table.

4.7.2.2 The other end shall be plugged or adapted to accept a petcock to remove air.

4.7.2.3 The coupling or adapter shall be filled with water until all air has been exhausted and the petcock closed.

4.7.2.4 Pressure shall be applied until the test pressure is reached.

4.7.2.5 The test pressure shall be held for at least 15 seconds but not more than 60 seconds.

4.8 Tensile Strength.

4.8.1 Couplings shall have a tensile strength of at least 1200 lb/in. (210 N/mm) of diameter. They shall be tested in accordance with 4.8.2 to prove compliance.

4.8.2 Tensile Strength Test.

4.8.2.1 A pair of couplings shall be attached to a section of hose.

4.8.2.2 The couplings shall be connected together and the hose installed in a tension testing machine such that the tension will be on the couplings.

4.8.2.3 A tensile load shall be applied at a rate of not more than 2 in. (51 mm) per minute up to 1200 lb/in. (210 N/mm) of nominal hose diameter.

4.8.3 After the tensile strength test, the couplings shall be subjected to a test pressure equal to the service test pressure of the hose to which they are attached. Any leakage or deformation shall constitute failure of this test.

4.9 Connect/Disconnect Capability.

4.9.1 Couplings shall be capable of being connected and disconnected at least 3000 times without leakage or failure. They shall be tested in accordance with 4.9.2 to prove compliance.

4.9.2 Connect/Disconnect Capability Test.

4.9.2.1 Tests shall be conducted on standard commercial product without lubrication.

4.9.2.2 Hose couplings shall be completely connected and disconnected to each other at least 3000 times.

4.9.2.3 At the completion of this portion of the test, the couplings shall be attached to hose such that tested couplings can be connected together.

4.9.2.4 The tested couplings when connected together shall withstand the service test pressure of the hose without leakage or failure.

4.10 Rough Usage.

4.10.1 Couplings shall be capable of being dropped up to 6 ft (1.8 m) without deformation or damage that impairs operation. They shall be tested in accordance with 4.10.2 to prove compliance.

4.10.2 Rough Usage Test.

4.10.2.1 Couplings shall be installed on approximately 10 ft (3 m) lengths of fire hose.

4.10.2.2 The couplings shall be coupled together, forming a loop in the hose.

4.10.2.3 The coupling assembly shall then be dropped onto a concrete surface from a height of 6 ft (1.8 m) so as to land as squarely as possible on the swivel ring.

4.10.2.4 The procedure in 4.10.2.3 shall be repeated three times.

4.10.2.5 The couplings shall operate freely and shall show no signs of deformation when inspected inside and outside.

4.10.2.6 Samples showing distortion or binding of the swivel mechanism shall be judged acceptable if the mechanism can be corrected to turn freely and evenly when straightened by the use of a hammer.

4.10.2.7 Samples developing cracks or broken sections either before or after attempts to straighten damaged portions shall be deemed as having failed the test. The coupling/hose assembly shall withstand the service test pressure of the hose without leakage or failure.

4.11 Coupling Retention.

4.11.1 Couplings shall remain on the hose without movement up to the rated burst pressure of the hose. They shall be tested in accordance with 4.11.2 to prove compliance.

4.11.2 Coupling Retention Test.

4.11.2.1 The couplings shall be attached to a 3 ft (1 m) length of hose.

4.11.2.2 The hose and coupling as an assembly shall be pressurized to the service pressure of the hose for 1 minute, and then the pressure shall be released.

4.11.2.3 The position of the coupling with relation to the hose shall be marked.

4.11.2.4 The pressure in the hose/coupling assembly shall then be raised at a rate of 300 psi/min to 1000 psi/min (2068 kPa/min to 6895 kPa/min) until the rated burst pressure of the hose is reached.

4.11.2.5 The pressure shall be held for a minimum of 15 seconds but not longer than 60 seconds.

4.11.2.6 The hose shall show no signs of movement from the coupling.

4.12 Vacuum Tightness.

4.12.1 When couplings are used on suction hose, they shall be capable of holding a vacuum of 22 in. Hg (74.2 kPa) for 5 minutes. They shall be tested in accordance with 4.12.2 to prove compliance.

4.12.2 Vacuum Tightness Test.

4.12.2.1 /The coupling shall be attached to a suitable section of suction hose.

4.12.2.2 A blank cap shall be attached to the coupling on one end, and a vacuum pump shall be attached to the other end.

4.12.2.3 A vacuum of 22 in. Hg (74.2 kPa) shall be developed within the assembly, and the assembly shall hold the vacuum for 5 minutes without any loss of vacuum.

4.13 Corrosion Resistance.

4.13.1 Couplings having parts other than high-strength yellow brass No. 8A as defined in ASTM B30, *Standard Specification for Copper Alloys in Ingot Form*, or ASTM B584, *Standard Specification for Copper Alloy Sand Castings for General Applications*, shall be capable of being coupled and uncoupled using accepted standard practices and shall not show any evidence of galvanic corrosion between dissimilar metals after testing in accordance with 4.13.2.

4.13.2 Coupling assemblies, including expansion rings and gaskets, shall be supported vertically in a fog chamber and exposed to salt spray (fog) as specified by ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*, for a period of 120 hours.

4.14 Nonmetallic Materials. Any nonmetallic material used in couplings except for the gaskets shall be certified by the manufacturer of the nonmetallic material as fit for the service intended.

4.15 High-Temperature Performance.

4.15.1 Temperatures up to 275°F (135°C) shall not affect the ease with which a coupling assembly is coupled or uncoupled. Couplings shall be tested in accordance with 4.15.2 to prove compliance.

4.15.2 High-Temperature Performance Test.

4.15.2.1 Dry couplings with gaskets installed shall be conditioned in an oven at 275°F (135°C) for 4 hours.

4.15.2.2 Immediately upon their removal from the oven, the torque to connect and disconnect the couplings shall be measured and shall be within the original torque range.

4.16 Low-Temperature Performance.

4.16.1 Temperatures down to –25°F ± 2°F (–32°C ± 1°C) shall not affect the performance of the coupling assembly. Couplings shall be tested in accordance with 4.16.2 to prove compliance.

4.16.2 Low-Temperature Performance Test.

4.16.2.1 With the gasket(s) installed, a coupling assembly shall be subjected to an environment of 0°F ± 1°F (–18°C ± 1°C) for a period of 24 hours and subsequently to an environment of –25°F ± 2°F (–32°C ± 1°C) for a period of 2 hours.

4.16.2.2 Following this exposure, the coupling shall be dropped from a height of 10 ft (3 m) onto its longitudinal axis.

4.16.2.3 The torque to connect and disconnect the couplings shall then be measured and be no greater than the torque required before the test.

4.17 Gasket Performance. The gasket material used with any coupling or adapter shall meet the test requirements of 4.17.1 through 4.17.3.

4.17.1 Low-Temperature Test.

4.17.1.1 Gaskets shall be subjected to an environment of 0°F ± 1°F (–18°C ± 1°C) for a period of 24 hours and subsequently to an environment of –25°F ± 2°F (–32°C ± 1°C) for a period of 2 hours.

4.17.1.2 Immediately upon removal from the test chamber, the gasket shall not crack when squeezed from any two opposite points into a figure 8 configuration.

4.17.2 Accelerated Aging Test.

4.17.2.1 Samples of the gasket material shall be prepared in accordance with the procedures described in ASTM D3183, *Standard Practice for Rubber — Preparation of Pieces for Test Purposes from Products*.

4.17.2.2 The samples of the gaskets shall then be subjected to oven aging at 212°F ± 3°F (100°C ± 2°C) for 70 hours in accordance with ASTM D573, *Standard Test Method for Rubber — Deterioration in an Air Oven*.

4.17.2.3 The samples shall then be tested for tensile strength and ultimate elongation, and the tensile strength shall be not less than 80 percent, and the ultimate elongation be not less than 50 percent of the corresponding properties of samples that have not been so treated.

4.17.3 Compression Set Test.

4.17.3.1 A sample of gasket material shall be compressed as defined in Method B of ASTM D395, *Standard Test Methods for Rubber Property — Compression Set*, and subjected to heat treatment at 158°F ± 1°F (70°C ± 1°C) for a period of 24 hours.

4.17.3.2 The compression set of the sample of gasket material so tested shall not exceed 15 percent of the original thickness.

4.18 Marking. The fire hose connection or fitting shall be permanently and legibly marked on the outside surface of the product, with the manufacturer's name or trademark, the thread size, and designation (e.g., 1½ in. NH). Minimum letter height shall be 0.1 in. (2.55 mm). Also, the fire hose connection or fitting shall be permanently and legibly marked on the outside surface of the product, with the country of manufacturing origin.

Chapter 5 Screw Threads for Couplings and Adapters (NFPA 1963)

5.1 Basic Form of Thread.

5.1.1 Basic thread form, as specified in Figure 5.1.1, shall have an included angle of 60 degrees and truncated top and bottom.

5.1.2 The basic angle of the thread between the sides of the thread measured in an axial plane shall be 60 degrees. The line bisecting this 60-degree angle shall be perpendicular to the axis of the screw thread.

5.1.3 The flat at the root and crest of the basic thread, as specified in Figure 5.1.1, shall be ⅛ times the pitch or 0.125 times the pitch *(p)*.

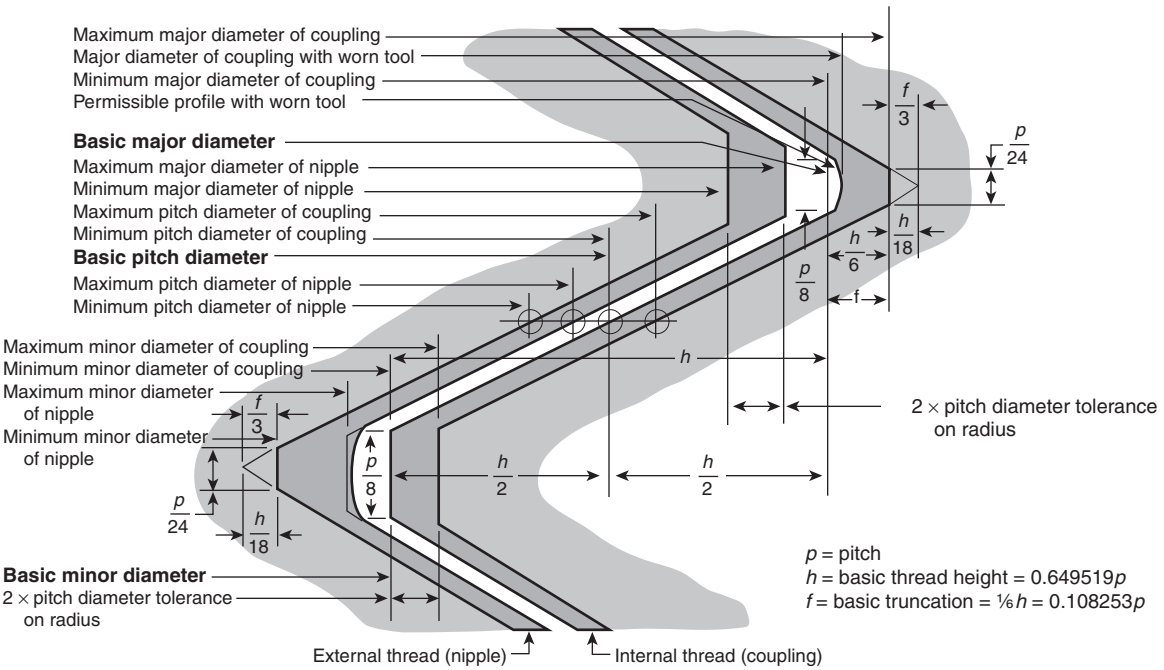


FIGURE 5.1.1 Form of Thread of American National Fire Hose Connection Screw Thread (NH) ***(See Table 5.4.1 for dimensions.)***

5.1.4 The height of the basic thread shall be

$$h = 0.649519 \times p \quad \text{or} \quad h = \frac{0.649519}{n} \qquad \textbf{[5.1.4]}$$

where:
h = basic thread height in inches
p = pitch in inches ($p = 1/n$)
n = number of threads per inch

5.1.5* Blunt Start.

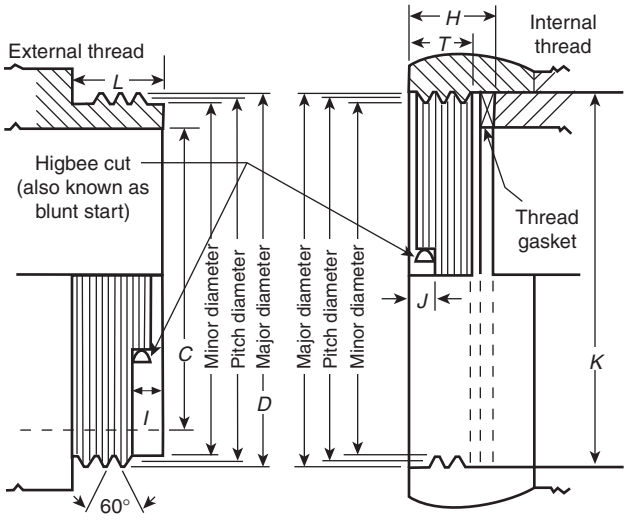
5.1.5.1 The outer ends of all external and internal threads shall be terminated by the blunt start, or Higbee cut, as shown in Figure 5.1.5.1, on full thread to avoid crossing and mutilation of thread.

5.1.5.2 The blunt start shall have a minimum length of not less than the radius formed by a cutter with a radius not less than the height of the thread.

5.1.5.3 The maximum length of the blunt start shall not exceed 10 degrees of arc.

5.2 Thread Series Designation.

5.2.1* Fire hose connection threads that meet the requirements of this chapter shall be identified as "American National Fire Hose Connection Screw Threads" (abbreviated throughout the standard with the thread symbol NH).



C = Inside diameter of connection waterway (nominal size of connection)
D = Approximate outside diameter of external thread (ODM)
H = Depth of internal connection
I = Length of the pilot from the face of the external connection to the start of the second thread (Higbee cut)
J = Distance from the face of the internal connection to the start of the second thread (Higbee cut)
K = Diameter of the gasket seat
L = Length of external thread
T = Length of internal thread

FIGURE 5.1.5.1 Nominal Dimensions of Connections ***(See Table 5.4.2 for dimensions.)***

5.2.2 The fire hose connection threads shall be designated by specifying in sequence the nominal size of the connection, the number of threads per inch, and the thread symbol "NH" as shown in the following example:

0.75-8 NH	3.5-6 NH
1-8 NH	4-4 NH
1.5-9 NH	4.5-4 NH
2.5-7.5 NH	5-4 NH
3-6 NH	6-4 NH
	8-4 NH

5.3 Dimensions of American National Fire Hose Connection Screw Threads (NH).

5.3.1 The basic major diameter, basic pitch diameter, and basic minor diameter and tolerances of the thread shall be as specified in Figure 5.1.1.

5.3.2 Nominal dimensions shall be as specified in Figure 5.1.5.1.

5.4 Thread Dimensions.

5.4.1 The basic dimensions for the threads shall be as specified in Table 5.4.1.

5.4.2 The nominal dimensions for the threads shall be as specified in Table 5.4.2.

5.4.3 The limiting dimensions for external threads (nipples) shall be as specified in Table 5.4.3.

5.4.4 The limiting dimensions for internal threads (couplings) shall be as specified in Table 5.4.4.

5.5 Tolerance.

5.5.1 The pitch-diameter tolerances for a mating external (nipple) and internal (coupling) thread shall be the same.

5.5.1.1 Pitch-diameter tolerances shall include lead and half-angle deviations.

5.5.1.2 Values for lead and half-angle deviations consuming one-half of the pitch-diameter tolerance shall be as specified in Table 5.5.1.2.

5.5.2 The tolerance relationships for the external (nipple) threads shall be as follows:

[5.5.2]

$$\text{Major diameter tolerance} = 2 \times \text{pitch diameter tolerance}$$

5.5.2.1 The minimum minor diameter of the external thread (nipple) shall be such as to result in a flat equal to ⅓ of the $p/8$ basic flat ($p/24$) at the root when the pitch diameter of the nipple is at its minimum value.

5.5.2.2 The maximum minor diameter is basic but shall be permitted to be such as results from the use of a worn or rounded threading tool.

5.5.2.3 The maximum minor diameter shall be as specified in Figure 5.1.1 and is the diameter on which the minor diameter tolerance formula shown in 5.5.2 shall be based.

Table 5.4.1 Basic Dimensions of NH Threads ***(See Figure 5.1.1.)***

Nominal Size of Connection	Threads per Inch (tpi)	Thread Designation (NH)	Pitch (p)	Basic Thread Height (h)	External Thread Dimensions (Nipple)				Minimum Internal Thread Dimensions		
					Allowance	Maximum Major Diameter, D - Col. 6	Maximum Pitch Diameter, Col. 7 - h	Maximum Minor Diameter, Col. 7 - $2h$	Minimum Minor Diameter, D - $2h$	Basic Pitch Diameter, D - h	Basic Major Diameter, D
1	2	3	4	5	6	7	8	9	10	11	12
¾	8	0.75-8 NH	0.12500	0.08119	0.0120	1.3750	1.2938	1.2126	1.2246	1.3058	1.3870
1	8	1-8 NH	0.12500	0.08119	0.0120	1.3750	1.2938	1.2126	1.2246	1.3058	1.3870
1½	9	1.5-9 NH	0.11111	0.07217	0.0120	1.9900	1.9178	1.8457	1.8577	1.9298	2.0020
2½	7.5	2.5-7.5 NH	0.13333	0.08660	0.0150	3.0686	2.9820	2.8954	2.9104	2.9970	3.0836
3	6	3-6 NH	0.16667	0.10825	0.0150	3.6239	3.5156	3.4073	3.4223	3.5306	3.6389
3½	6	3.5-6 NH	0.16667	0.10825	0.0200	4.2439	4.1356	4.0273	4.0473	4.1556	4.2639
4	4	4-4 NH	0.25000	0.16238	0.0250	5.0109	4.8485	4.6861	4.7111	4.8735	5.0359
4½	4	4.5-4 NH	0.25000	0.16238	0.0250	5.7609	5.5985	5.4361	5.4611	5.6235	5.7859
5	4	5-4 NH	0.25000	0.16238	0.0250	6.2600	6.0976	5.9352	5.9602	6.1226	6.2850
6	4	6-4 NH	0.25000	0.16238	0.0250	7.0250	6.8626	6.7002	6.7252	6.8876	7.0500
8	4	8-4 NH	0.25000	0.16238	0.0250	9.0250	8.8626	8.7002	8.7252	8.8876	9.0500

Note: All values are in inches except for columns 2 and 3.

Table 5.4.2 Nominal Dimensions of NH Threads *(See Figure 5.1.5.1.)*

Nominal Size of Connection Waterway, *C*	Threads per Inch (tpi)	Thread Designation (NH)	Approximate Outside Diameter of External Thread, *D**	Length of External Thread (Min), *L*	Length of Pilot to Start of Second Thread (External), *I*	Depth of Internal Connector, *H*	Diameter of Gasket Seat in Coupling, *K*	Length of Internal Thread, *T*	Length of Pilot to Start of Second Thread (Internal), *J*
1	2	3	4	5	6	7	8	9	10
¾	8	0.75-8 NH	1⅜	⅝	5/32	19/32	1 7/16	13/32	5/32
1	8	1-8 NH	1⅜	⅝	5/32	19/32	1 7/16	13/32	5/32
1½	9	1.5-9 NH	2	⅝	5/32	19/32	2 1/16	13/32	5/32
2½	7½	2.5-7.5 NH	3 1/16	1	¼	15/16	3 3/16	11/16	3/16
3	6	3-6 NH	3⅝	1⅛	5/16	1 1/16	3¾	¾	¼
3½	6	3.5-6 NH	4¼	1⅛	5/16	1 1/16	4⅜	¾	¼
4	4	4-4 NH	5	1¼	7/16	1 3/16	5⅛	⅞	⅜
4½	4	4.5-4 NH	5¾	1¼	7/16	1 3/16	5⅞	⅞	⅜
5	4	5-4 NH	6¼	1⅜	7/16	1 5/16	6⅜	1	⅜
6	4	6-4 NH	7 1/32	1⅜	7/16	1 5/16	7⅛	1	⅜
8	4	8-4 NH	9 1/32	1½	7/16	1 7/16	9⅛	1⅛	⅜

Note: All values are in inches except for columns 2 and 3.
*Approximate dimensions are for field identification purposes only. Exact basic manufacturing dimensions and tolerances are given in subsequent tables.

Table 5.4.3 Limits of Size and Tolerances of NH External Threads (Nipples)

Nominal Size of Connection	Threads per Inch (tpi)	Thread Designation (NH)	Pitch (*p*)	Basic Thread Height (*h*)	External Thread (Nipple)						
					Major Diameter			Pitch Diameter			Minor Diameter*
					Maximum	Minimum	Tolerance	Maximum	Minimum	Tolerance	Maximum
1	2	3	4	5	6	7	8	9	10	11	12
¾	8	0.75-8 NH	0.12500	0.08119	1.3750	1.3528	0.0222	1.2938	1.2827	0.0111	1.2126
1	8	1-8 NH	0.12500	0.08119	1.3750	1.3528	0.0222	1.2938	1.2827	0.0111	1.2126
1½	9	1.5-9 NH	0.11111	0.07217	1.9900	1.9678	0.0222	1.9178	1.9067	0.0111	1.8457
2½	7.5	2.5-7.5 NH	0.13333	0.08660	3.0686	3.0366	0.0320	2.9820	2.9660	0.0160	2.8954
3	6	3-6 NH	0.16667	0.10825	3.6239	3.5879	0.0360	3.5156	3.4976	0.0180	3.4073
3½	6	3.5-6 NH	0.16667	0.10825	4.2439	4.2079	0.0360	4.1356	4.1176	0.0180	4.0273
4	4	4-4 NH	0.25000	0.16238	5.0109	4.9609	0.0500	4.8485	4.8235	0.0250	4.6861
4½	4	4.5-4 NH	0.25000	0.16238	5.7609	5.7109	0.0500	5.5985	5.5735	0.0250	5.4361
5	4	5-4 NH	0.25000	0.16238	6.2600	6.2100	0.0500	6.0976	6.0726	0.0250	5.9352
6	4	6-4 NH	0.25000	0.16238	7.0250	6.9750	0.0500	6.8626	6.8376	0.0250	6.7002
8	4	8-4 NH	0.25000	0.16238	9.0250	8.9750	0.0500	8.8626	8.8376	0.0250	8.7002

Note: All values are in inches except for columns 2 and 3.
*Dimensions given for the maximum minor diameter of the nipple are figured to the intersection of the worn tool arc with a centerline through crest and root. The minimum minor diameter of the nipple shall be that corresponding to a flat at the minor diameter of the minimum nipple equal to $p/24$ and may be determined by subtracting 11 $h/9$ (or 0.7939p) from the minimum pitch diameter of the nipple.

Table 5.4.4 Thread Limits of Size and Tolerances of NH Internal Threads (Couplings)

Nominal Size of Connection	Threads per Inch (tpi)	Thread Designation (NH)	Pitch (p)	Basic Thread Height (h)	Internal Thread (Coupling)						
					Minor Diameter			Pitch Diameter			Major Diameter*
					Minimum	Maximum	Tolerance	Minimum	Maximum	Tolerance	Minimum
1	2	3	4	5	6	7	8	9	10	11	12
¾	8	0.75-8 NH	0.12500	0.08119	1.2246	1.2468	0.0222	1.3058	1.3169	0.0111	1.3870
1	8	1-8 NH	0.12500	0.08119	1.2246	1.2468	0.0222	1.3058	1.3169	0.0111	1.3870
1½	9	1.5-9 NH	0.11111	0.07217	1.8577	1.8799	0.0222	1.9298	1.9409	0.0111	2.0020
2½	7.5	2.5-7.5 NH	0.13333	0.08660	2.9104	2.9424	0.0320	2.9970	3.0130	0.0160	3.0836
3	6	3-6 NH	0.16667	0.10825	3.4223	3.4583	0.0360	3.5306	3.5486	0.0180	3.6389
3½	6	3.5-6 NH	0.16667	0.10825	4.0473	4.0833	0.0360	4.1556	4.1736	0.0180	4.2639
4	4	4-4 NH	0.25000	0.16238	4.7111	4.7611	0.0500	4.8735	4.8985	0.0250	5.0359
4½	4	4.5-4 NH	0.25000	0.16238	5.4611	5.5111	0.0500	5.6235	5.6485	0.0250	5.7859
5	4	5-4 NH	0.25000	0.16238	5.9602	6.0102	0.0500	6.1226	6.1476	0.0250	6.2850
6	4	6-4 NH	0.25000	0.16238	6.7252	6.7752	0.0500	6.8876	6.9126	0.0250	7.0500
8	4	8-4 NH	0.25000	0.16238	8.7252	8.7752	0.0500	8.8876	8.9126	0.0250	9.0500

Note: All values are in inches except for columns 2 and 3.

*Dimensions for the minimum major diameter of the coupling correspond to the basic flat $p/8$, and the profile at the major diameter produced by a worn tool must not fall below the basic outline. The maximum major diameter of the coupling shall be that corresponding to a flat at the major diameter of the maximum coupling equal to $p/24$ and can be determined by adding $11h/9$ (or $0.7939p$) to the maximum pitch diameter of the coupling.

5.5.3 The tolerance relationships for the internal (coupling) threads shall be as follows:

[5.5.3]

$$\text{Minor diameter tolerance} = \text{pitch diameter tolerance} + 2h/9.$$

5.5.3.1 The minimum minor diameter of a coupling shall be such as to result in a basic flat, $p/8$, at the crest when the pitch diameter of the coupling is at its minimum value.

5.6 Gauges and Gauging NH Threads.

5.6.1 The limits of size for the gauges to be used in the gauging of fire hose connections shall be as specified in Table 5.6.1(a), Table 5.6.1(b), and Table 5.6.1(c).

5.6.2 For these gauges, the allowable variation in lead between any two threads not farther apart than the length of engagement shall be ±0.0004 in. The allowable variation in half-angle of thread shall be ±5 minutes.

5.6.3* Except as otherwise specified herein, the gauges and gauging practices shall conform to ANSI/ASME B1.2, *Gages and Gaging for Unified Inch Screw Threads.*

5.6.4* Adjustable thread ring gauges shall be set by means of threaded setting plug gauges, the dimensions of which are given in Table 5.6.1(a). Means of setting ring gauges shall be as specified in ANSI/ASME B1.2, *Gages and Gaging for Unified Inch Screw Threads.*

Table 5.5.1.2 Lead and Half-Angle Deviations Consuming One-Half of Pitch-Diameter Tolerances for NH Threads

Nominal Size of Connection	Thread per Inch (tpi)	Thread Designation (NH)	Pitch-Diameter Tolerance[a]	Lead Deviation Consuming One-Half of Pitch-Diameter Tolerance[b]	Half-Angle Deviation Consuming One-Half of Pitch-Diameter Tolerance	
					Degree	Minute
1	2	3	4	5	6	7
¾	8	0.75-8 NH	0.0111	0.0032	1	42
1	8	1-8 NH	0.0111	0.0032	1	42
1½	9	1.5-9 NH	0.0111	0.0032	1	54
2½	7.5	2.5-7.5 NH	0.0160	0.0046	2	17
3	6	3-6 NH	0.0180	0.0052	2	4
3½	6	3.5-6 NH	0.0180	0.0052	2	4
4	4	4-4 NH	0.0250	0.0072	1	55
4½	4	4.5-4 NH	0.0250	0.0072	1	55
5	4	5-4 NH	0.0250	0.0072	1	55
6	4	6-4 NH	0.0250	0.0072	1	55
8	4	8-4 NH	0.0250	0.0072	1	55

Note: All values are in inches except for columns 2, 3, and 6.

[a]The tolerances specified for pitch diameter include all deviations of pitch diameter, lead, and angle. The full tolerance cannot, therefore, be used on pitch diameter unless the lead and angle of the thread are perfect. The last two columns give, for information, the deviations in lead and in angle, each of which can be compensated for by half the pitch-diameter tolerance given in this column. If lead and angle deviations both exist to the amount tabulated, the pitch diameter of a nipple, for example, must be reduced by the full tolerance or it will not enter the GO gauge.

[b]Between any two threads not farther apart than the length of engagement.

Table 5.6.1(a) Setting Thread Plug Limits of Size for NH Thread Ring Gauges

Nominal Size of Connection	Threads per Inch (tpi)	Thread Designation (NH)		X Truncated Setting Plugs						X Basic-Crest Setting Plugs*	
				Plug for GO Thread Gauge			Plug for LO (NOT GO) Thread Gauge			Major Diameter	
				Major Diameter		Pitch Diameter	Major Diameter		Pitch Diameter	Plug for GO Thread Gauge	Plug for LO (NOT GO) Thread Gauge
				Truncated	Full		Truncated	Full			
Gauge Tolerance				-	+	-	-	+	+	+	+
1	2	3	4	5	6	7	8	9	10	11	12
¾	8	0.75-8 NH	**Max**	1.3579	1.3757	1.2938	1.3368	1.3757	1.2831	1.3757	1.3757
			Min	1.3572	1.3750	1.2934	1.3361	1.3750	1.2827	1.3750	1.3750
1	8	1-8 NH	**Max**	1.3579	1.3757	1.2938	1.3368	1.3757	1.2831	1.3757	1.3757
			Min	1.3572	1.3750	1.2934	1.3361	1.3750	1.2827	1.3750	1.3750
1½	9	1.5-9 NH	**Max**	1.9742	1.9907	1.9178	1.9548	1.9907	1.9071	1.9907	1.9907
			Min	1.9735	1.9900	1.9174	1.9541	1.9900	1.9067	1.9900	1.9900
2½	7.5	2.5-7.5 NH	**Max**	3.0507	3.0693	2.9820	3.0237	3.0693	2.9665	3.0693	3.0693
			Min	3.0500	3.0686	2.9815	3.0230	3.0686	2.9660	3.0686	3.0686
3	6	3-6 NH	**Max**	3.6029	3.6247	3.5156	3.5698	3.6247	3.4981	3.6247	3.6247
			Min	3.6021	3.6239	3.5151	3.5690	3.6239	3.4976	3.6239	3.6239
3½	6	3.5-6 NH	**Max**	4.2229	4.2452	4.1356	4.1898	4.2452	4.1182	4.2452	4.2452
			Min	4.2216	4.2439	4.1350	4.1885	4.2439	4.1176	4.2439	4.2439
4	4	4-4 NH	**Max**	4.9828	5.0124	4.8485	4.9318	5.0124	4.8241	5.0124	5.0124
			Min	4.9813	5.0109	4.8479	4.9303	5.0109	4.8235	5.0109	5.0109
4½	4	4.5-4 NH	**Max**	5.7328	5.7624	5.5985	5.6818	5.7624	5.5741	5.7624	5.7624
			Min	5.7313	5.7609	5.5979	5.6803	5.7609	5.5735	5.7609	5.7609
5	4	5-4 NH	**Max**	6.2319	6.2615	6.0976	6.1809	6.2615	6.0732	6.2615	6.2615
			Min	6.2304	6.2600	6.0970	6.1794	6.2600	6.0726	6.2600	6.2600
6	4	6-4 NH	**Max**	6.9969	7.0265	6.8626	6.9459	7.0265	6.8382	7.0265	7.0265
			Min	6.9954	7.0250	6.8620	6.9444	7.0250	6.8376	7.0250	7.0250
8	4	8-4 NH	**Max**	8.9969	9.0265	8.8626	8.9459	9.0265	8.8382	9.0265	9.0265
			Min	8.9954	9.0250	8.8620	8.9444	9.0250	8.8376	9.0250	9.0250

Notes:
(1) Gauge limit values in this table have been obtained in accordance with ANSI/ASME B1.2, *Gages and Gaging for Unified Inch Screw Threads.*
(2) All other values are in inches.
*Pitch-diameter limits for basic-crest GO setting plugs are the same as those shown in column 7. Pitch-diameter limits for basic-crest LO (NOT GO) setting plugs are the same as those shown in column 10.

Table 5.6.1(b) Gauge Limits of Size for Ring Gauges for NH External (Nipple) Threads

Nominal Size of Connection	Threads per Inch (tpi)	Thread Designation (NH)		X Thread Ring Gauges				Z Plain Ring Gauges	
				GO		LO (NOT GO)		Major Diameter	
				Pitch Diameter	Minor Diameter	Pitch Diameter	Minor Diameter	GO	NOT GO
Gauge Tolerance				-	-	+	+	-	-
1	2	3	4	5	6	7	8	9	10
¾	8	0.75-8 NH	**Max**	1.2938	1.2246	1.2831	1.2563	1.37500	1.35292
			Min	1.2934	1.2239	1.2827	1.2556	1.37488	1.35280
1	8	1-8 NH	**Max**	1.2938	1.2246	1.2831	1.2563	1.37500	1.35292
			Min	1.2934	1.2239	1.2827	1.2556	1.37488	1.35280
1½	9	1.5-9 NH	**Max**	1.9178	1.8577	1.9071	1.8833	1.99000	1.96796
			Min	1.9174	1.8570	1.9067	1.8826	1.98984	1.96780
2½	7.5	2.5-7.5 NH	**Max**	2.9820	2.9104	2.9665	2.9378	3.06860	3.03680
			Min	2.9815	2.9097	2.9660	2.9371	3.06840	3.03660
3	6	3-6 NH	**Max**	3.5156	3.4223	3.4981	3.4623	3.62390	3.58810
			Min	3.5151	3.4215	3.4976	3.4615	3.62370	3.58790
3½	6	3.5-6 NH	**Max**	4.1356	4.0473	4.1182	4.0828	4.24390	4.20810
			Min	4.1350	4.0460	4.1176	4.0815	4.24370	4.20790
4	4	4-4 NH	**Max**	4.8485	4.7111	4.8241	4.7709	5.01090	4.96115
			Min	4.8479	4.7096	4.8235	4.7694	5.01065	4.96090
4½	4	4.5-4 NH	**Max**	5.5985	5.4611	5.5741	5.5209	5.76090	5.71115
			Min	5.5979	5.4596	5.5735	5.5194	5.76065	5.71090
5	4	5-4 NH	**Max**	6.0976	5.9602	6.0732	6.0200	6.26000	6.21025
			Min	6.0970	5.9587	6.0726	6.0185	6.25975	6.21000
6	4	6-4 NH	**Max**	6.8626	6.7252	6.8382	6.7850	7.02500	6.97532
			Min	6.8620	6.7237	6.8376	6.7835	7.02468	6.97500
8	4	8-4 NH	**Max**	8.8626	8.7252	8.8382	8.7850	9.02500	8.97532
			Min	8.8620	8.7237	8.8376	8.7835	9.02468	8.97500

Notes:
(1) Gauge limit values in this table have been obtained in accordance with ANSI/ASME B1.2, *Gages and Gaging for Unified Inch Screw Threads,* except for the values shown in column 6. The maximum values shown in column 6 are values for the minimum minor diameter of the internal thread.
(2) All other values are in inches.

Table 5.6.1(c) Gauge Limits of Size for Plug Gauges for NH Internal (Coupling) Threads

Nominal Size of Connection	Threads per Inch (tpi)	Thread Designation (NH)		X Thread Plug Gauges				Z Plain Plug Gauges	
				GO		HI (NOT GO)		Minor Diameter	
				Major Diameter	Pitch Diameter	Major Diameter	Pitch Diameter	GO	NOT GO
Gauge Tolerance				+	+	-	-	+	-
1	2	3	4	5	6	7	8	9	10
¾	8	0.75-8 NH	**Max**	1.3877	1.3062	1.3710	1.3169	1.22472	1.24680
			Min	1.3870	1.3058	1.3703	1.3165	1.22460	1.24668
1	8	1-8 NH	**Max**	1.3877	1.3062	1.3710	1.3169	1.22472	1.24680
			Min	1.3870	1.3058	1.3703	1.3165	1.22460	1.24668
1½	9	1.5-9 NH	**Max**	2.0027	1.9302	1.9890	1.9409	1.85786	1.87990
			Min	2.0020	1.9298	1.9883	1.9405	1.85770	1.87974
2½	7.5	2.5-7.5 NH	**Max**	3.0843	2.9975	3.0707	3.0130	2.91060	2.94240
			Min	3.0836	2.9970	3.0700	3.0125	2.91040	2.94220
3	6	3-6 NH	**Max**	3.6397	3.5311	3.6208	3.5486	3.42250	3.45830
			Min	3.6389	3.5306	3.6200	3.5481	3.42230	3.45810
3½	6	3.5-6 NH	**Max**	4.2652	4.1562	4.2458	4.1736	4.04750	4.08330
			Min	4.2639	4.1556	4.2445	4.1730	4.04730	4.08310
4	4	4-4 NH	**Max**	5.0374	4.8741	5.0068	4.8985	4.71135	4.76110
			Min	5.0359	4.8735	5.0053	4.8979	4.71110	4.76085
4½	4	4.5-4 NH	**Max**	5.7874	5.6241	5.7568	5.6485	5.46135	5.51110
			Min	5.7859	5.6235	5.7553	5.6479	5.46110	5.51085
5	4	5-4 NH	**Max**	6.2865	6.1232	6.2559	6.1476	5.96045	6.01020
			Min	6.2850	6.1226	6.2544	6.1470	5.96020	6.00995
6	4	6-4 NH	**Max**	7.0515	6.8882	7.0209	6.9126	6.72552	6.77520
			Min	7.0500	6.8876	7.0194	6.9120	6.72520	6.77488
8	4	8-4 NH	**Max**	9.0515	8.8882	9.0209	8.9126	8.72552	8.77520
			Min	9.0500	8.8876	9.0194	8.9120	8.72520	8.77488

Notes:
(1) Gauge limit values in this table have been obtained in accordance with ANSI/ASME B1.2, *Gages and Gaging for Unified Inch Screw Threads.*
(2) All other values are in inches.

Chapter 6 Nonthreaded Connections (NFPA 1963)

6.1* General. The requirements of Chapters 1 through 4 and the requirements of this chapter shall apply to nonthreaded connections in the 4 in. (100 mm), 5 in. (125 mm), and 6 in. (150 mm) sizes.

6.2* Gauges.

6.2.1 The dimensional characteristics and tolerances for the metal-face gauges to be used in the gauging of nonthreaded connections shall be as specified in Figure 6.2.1(a) for a Type A test gauge for 4 in. (102 mm) or 5 in. (127 mm) connections or Figure 6.2.1(c) for 6 in. (152 mm) connections and Figure 6.2.1(b) for a Type B test gauge for 4 in. (102 mm) or 5 in. (127 mm) connections or Figure 6.2.1(d) for 6 in. (152 mm) connections.

6.2.2 In addition to the requirement in 6.2.1, the following shall be met:

(1) The 4 in. (100 mm) metal-face gauge shall meet the dimensional characteristics of Figure 6.2.2(a).
(2) The 5 in. (125 mm) metal-face gauge shall meet the dimensional characteristics of Figure 6.2.2(b).
(3) The 6 in. (150 mm) metal-face gauge shall meet the dimensional characteristics of Figure 6.2.2(c).

6.3 Locks.

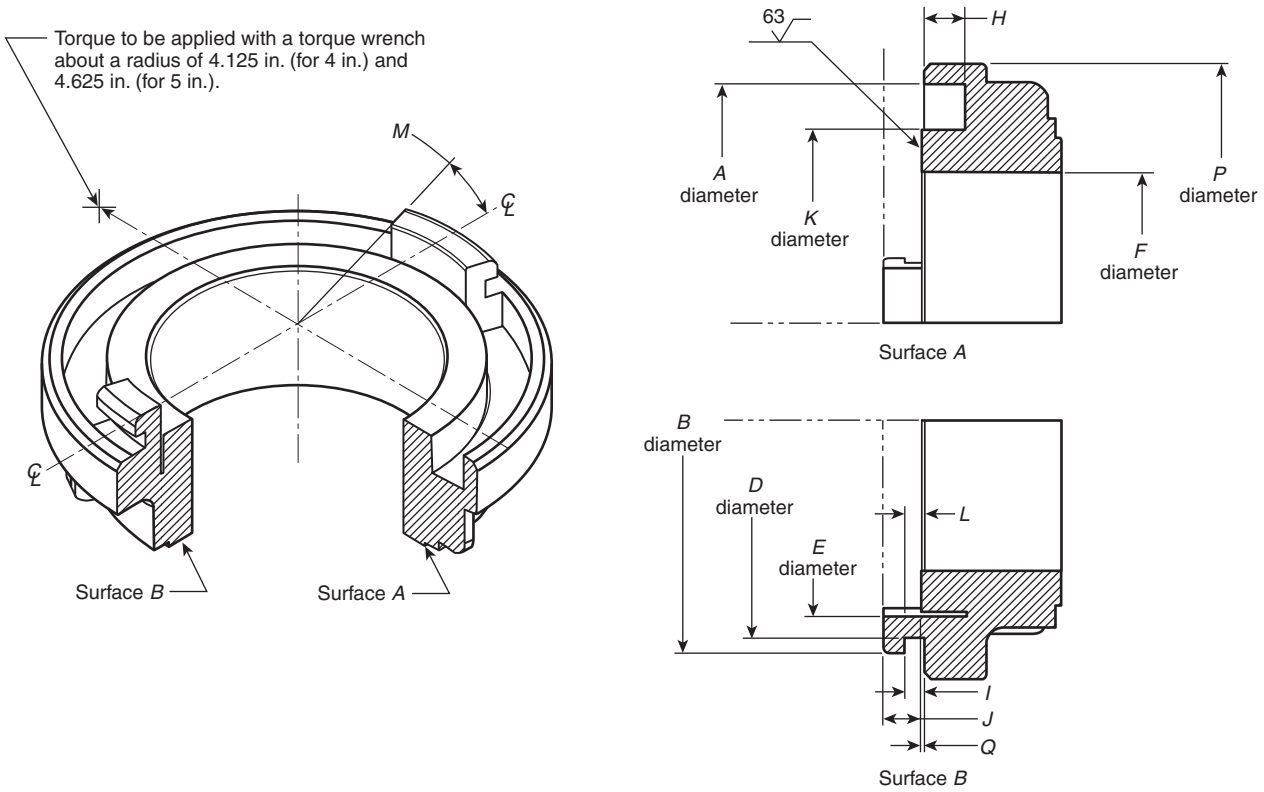
6.3.1* All gasketed nonthreaded connections shall be provided with locks within the confines of the nonthreaded connection to ensure against unintentional disconnection.

6.3.2 Caps for use with nonthreaded connections shall be permitted without a lock.

6.3.3 The locks shall be located so that the nonthreaded connection will connect to the Type A metal-face test gauge and lock.

6.3.4 The locks shall be designed so as to lock automatically when connecting two nonthreaded connections without additional action needed to engage the locks. The lock shall not be capable of being secured (mechanically) in the open (unlocked) position.

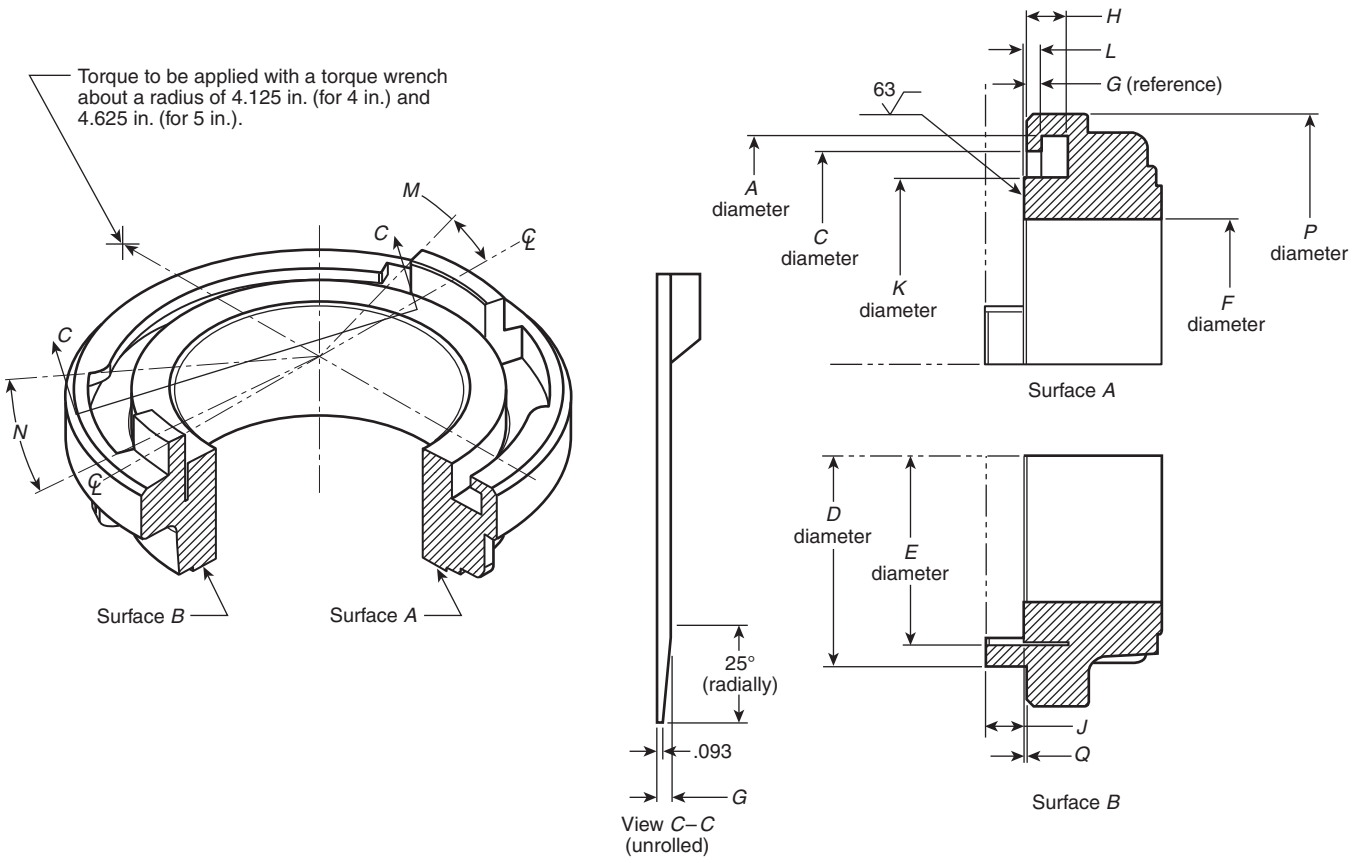
6.3.5 The locks shall be field repairable.



Size	A	B	D	E	F	H	I	J	K	L	M	P	Q
4 in.	5.500	5.472	5.118	4.528	3.500	0.576	0.236	0.532	4.500	0.213±.002	15°	6.142	0.023±.002
5 in.	6.957	6.929	6.496	5.826	4.500	0.653	0.295	0.622	5.750	0.258±.002	16°	7.717	0.038±.002

Notes:
(1) All linear measurements in inches. Tolerances: X.XXX ± 0.005 in. unless otherwise noted.
(2) All dimensions are to be the same for similar configurations on gauges.

FIGURE 6.2.1(a) Dimensions for Type A Test Gauge (No Ramp Angle).



Size	A	C	D	E	F	G	H	J	K	L	M	N	P	Q
4 in.	5.500	5.197	5.118	4.528	3.500	0.190	0.576	0.532	4.500	0.213±.002	15°	35°	6.142	0.023±.002
5 in.	6.957	6.575	6.496	5.826	4.500	0.220	0.653	0.622	5.750	0.258±.002	16°	36°	7.717	0.038±.002

Notes:
(1) All linear measurements in inches. Tolerances: X.XXX ± 0.005 in. unless otherwise noted.
(2) All dimensions are to be the same for similar configurations on gauges.

FIGURE 6.2.1(b) Dimensions for Type B Test Gauge (with Lugs Removed).

6.3.6 The locks shall be designed so as to be disengaged by hand in a separate action other than that needed to disconnect the nonthreaded connection.

6.3.6.1 The locks shall be capable of being unlocked by a firefighter wearing gloves meeting the requirements of NFPA 1971.

6.3.6.2 A device such as a wrench incorporating actions to disengage the lock and disconnect the nonthreaded connection in one motion shall be permitted to be used.

6.3.7 The lock mechanism shall not shear when a force of 300 lb × ft (407 N × m) is applied at the nut on the test wrench.

6.4 Indicators. Permanent indicators, obvious to sight and touch, shall be located at two points 180 degrees apart, as shown on Figure 6.2.2(a) and Figure 6.2.2(b), to indicate the fully engaged position of the connections.

6.5 Force to Connect and Disconnect.

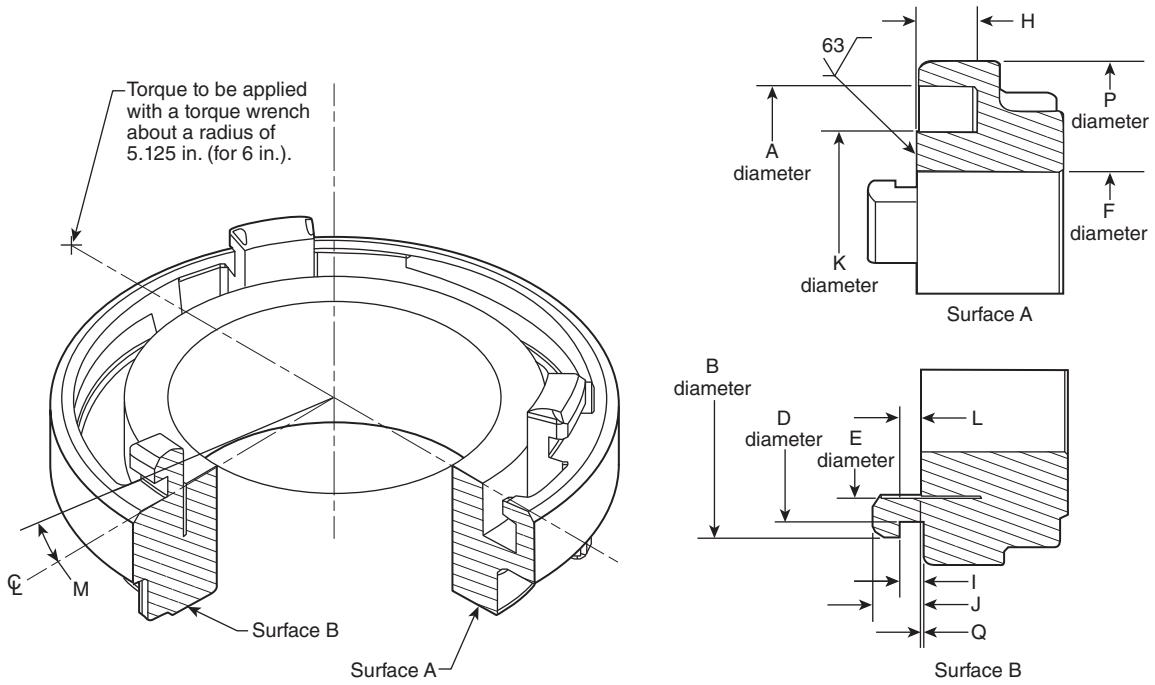
6.5.1* All nonthreaded pressure connections shall be capable of connection and disconnection to both the Type A and the Type B metal-face test gauges at a force of between 6.0 lb × in. (0.68 N × m) and 30 lb × in. (3.4 N × m) when measured as described in 6.5.5 and under the conditions described in 6.5.6 and 6.5.7.

6.5.2 The force to connect and disconnect nonthreaded pressure connections to each other shall not exceed 40 lb × in. (4.5 N × m) when measured as described in 6.5.5 and under the conditions described in 6.5.6 and 6.5.7.

6.5.3 All nonthreaded suction connections shall be capable of connection and disconnection to both the Type A and the Type B metal-face test gauges at a force of between 168 lb × in. (19.0 N × m) and 312 lb × in. (35.3 N × m) when measured as described in 6.5.5 and under the conditions described in 6.5.6 and 6.5.7.

6.5.4 The force to connect and disconnect nonthreaded suction connections to each other shall not exceed 360 lb × in. (40.7 N × m) when measured as described in 6.5.5 and under the conditions described in 6.5.6 and 6.5.7.

6.5.5* The force to connect and disconnect shall be tested as described in 6.5.5.1 through 6.5.5.7.2.



Size	A	B	D	E	F	H	I	J	K	L	M	P	Q
6 in.	7.696	7.576	7.046	6.342	5.0	0.902	0.378	0.807	6.276	0.352±.002	10°	8.456	0.026±.002

Notes:
(1) All linear measurements in inches, Tolerances: X.XXX±.005 in. unless otherwise noted.
(2) All dimensions are to be the same for similar configurations on gauges.

FIGURE 6.2.1(c) Dimensions for Type A Test Gauge (No Ramp Angle).

6.5.5.1 One of the metal-face test gauges, or one-half of a pressure or suction connector, depending on the force to be checked, shall be secured in a vise or similar device.

6.5.5.2 The connector to be tested shall be free to turn without constraint or assistance.

6.5.5.3 For 4 in. (100 mm) connectors, a test wrench with dimensions as shown in Figure 6.5.5.3 shall be attached over the external lugs of the connector being tested.

6.5.5.4 For 5 in. (125 mm) connectors, a test wrench with dimensions as shown in Figure 6.5.5.4 shall be attached over the external lugs of the connector to be tested.

6.5.5.5 For 6 in. (150 mm) connectors, a test wrench with dimensions as shown in Figure 6.5.5.5 shall be attached over the external lugs of the connector to be tested.

6.5.5.6 A standard torque wrench measuring inch-pounds shall be connected to the test wrench.

6.5.5.7 The torque wrench shall be moved in the direction necessary to connect or disconnect the connector being tested.

6.5.5.7.1 The lock shall be held open only when the connector is being disconnected.

6.5.5.7.2 The torque wrench shall be in direct line with the center of the connector when the torque reading is being taken.

6.5.6 The force to connect and disconnect test shall be done at 70°F (21°C) ambient temperature.

6.5.7 The gaskets shall be clean but not lubricated.

6.6* Caps. All nonthreaded caps shall have gaskets installed.

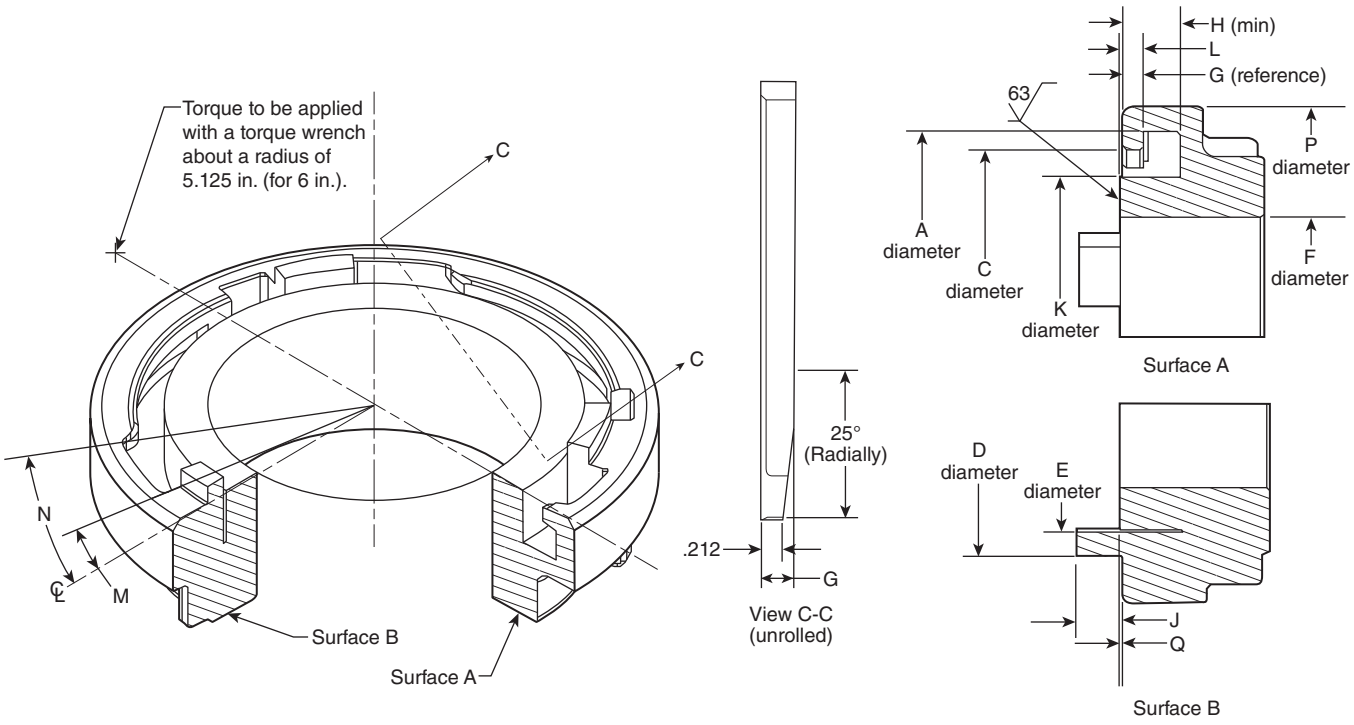
6.6.1 Installation and Removal of Nonthreaded Caps.

6.6.1.1 Utilization without a tool. Nonthreaded caps designed to be removed without the use of a tool shall require a force between 6 lbf in. and 30 lbf in. to install and remove.

6.6.1.2 Utilization with a tool. Nonthreaded caps designed for the use of a tool to remove shall require a force of 168 lbf in. to 312 lbf in. to install and remove.

6.6.2* The cap used for a nonthreaded fire department connection shall be provided with a means of indicating water pressure behind the cap.

6.7 Adapters. All nonthreaded adapters shall have gaskets installed.



Size	A	C	D	E	F	G	H	J	K	L	M	N	P	Q
6 in.	7.696	7.11	7.046	6.342	5.0	0.32	0.902	0.807	6.276	0.352±.002	10°	22°	8.456	0.026±.002

Notes:

(1) All linear measurements in inches, Tolerances: X.XXX±.005 in. unless otherwise noted.
(2) All dimensions are to be the same for similar configurations on gauges.

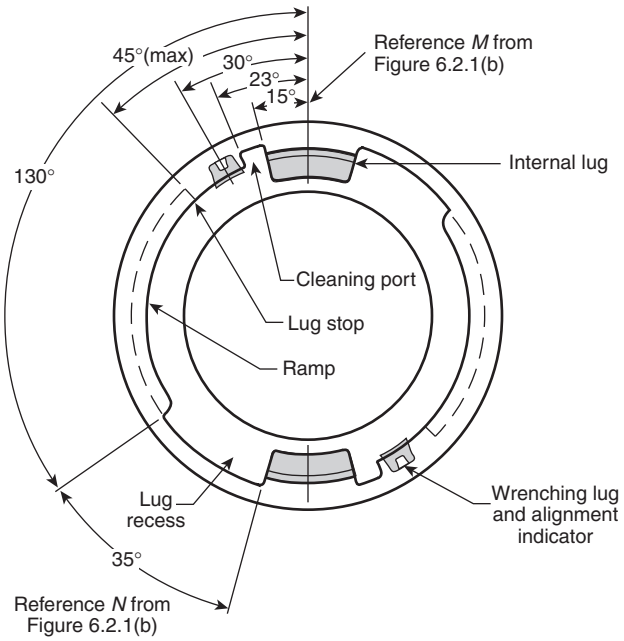
FIGURE 6.2.1(d) Dimensions for Type B Test (with Lugs Removed).

6.8 Hydrant and Fire Department Connections.

6.8.1 Nonthreaded hydrant and fire department connections shall be metal-faced, without gaskets.

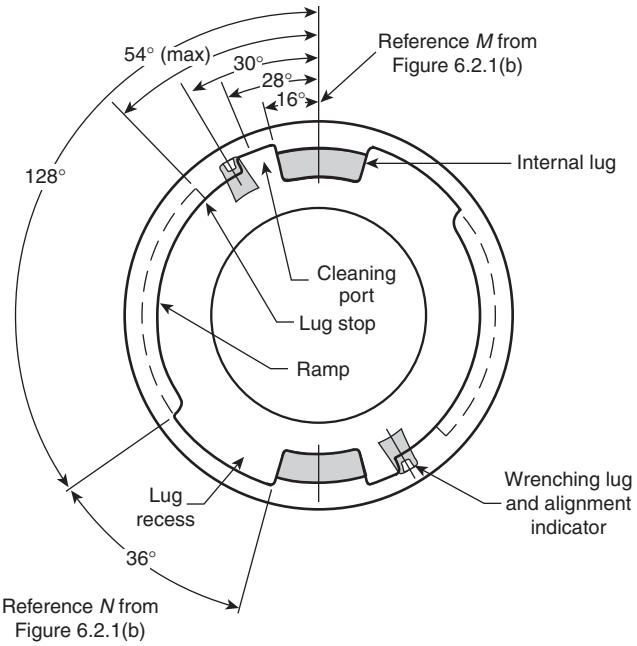
6.8.2 Nonthreaded hydrant and fire department connections shall be made to the dimensions specified in Figure 6.8.2(a) for 4 in. (100 mm) and 5 in. (125 mm) connections and Figure 6.8.2(b) for 6 in. (150 mm) connections.

6.8.3 In addition, 4 in. (100 mm) metal-faced hydrant and fire department connections shall meet the dimensional characteristics of Figure 6.2.2(a), and the 5 in. (125 mm) metal-faced hydrant and fire department connections shall meet the dimensional characteristics of Figure 6.2.2(b).



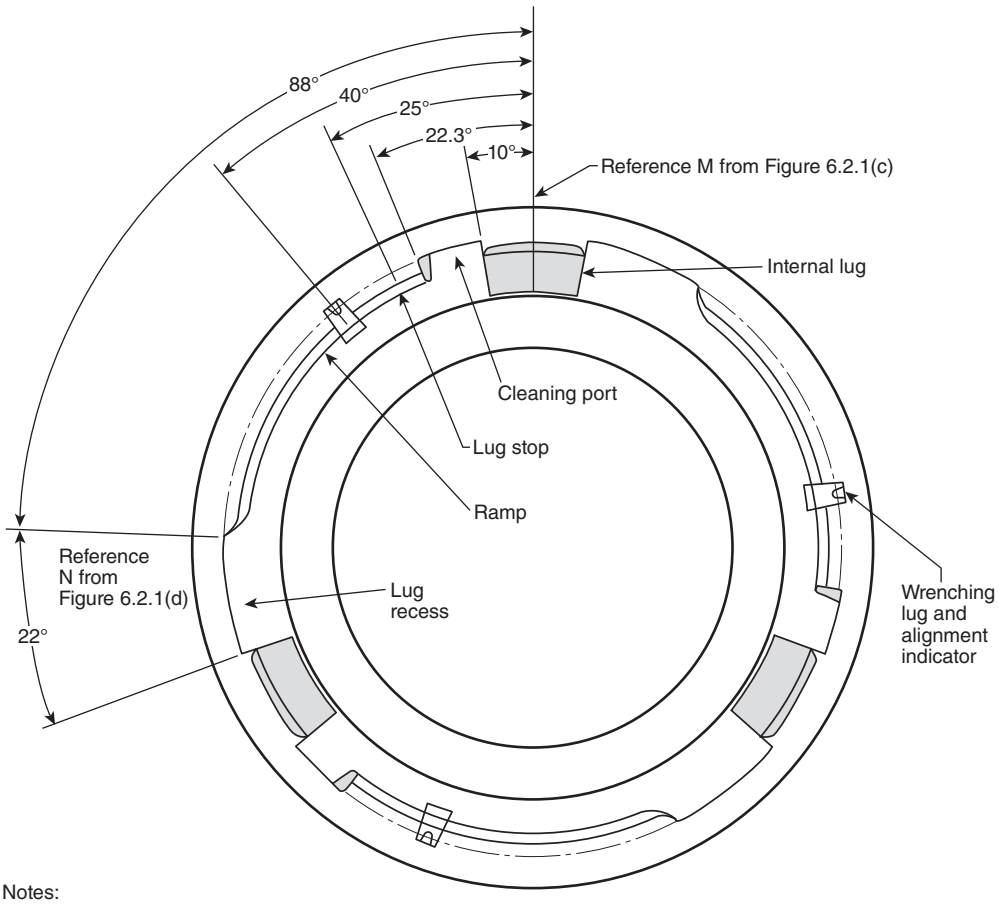
Note: All dimensions are to be the same for similar configurations on the gauge.

FIGURE 6.2.2(a) End View of 4 in. (100 mm) Metal-Face Gauge and Nonthreaded 4 in. (100 mm) Connections.



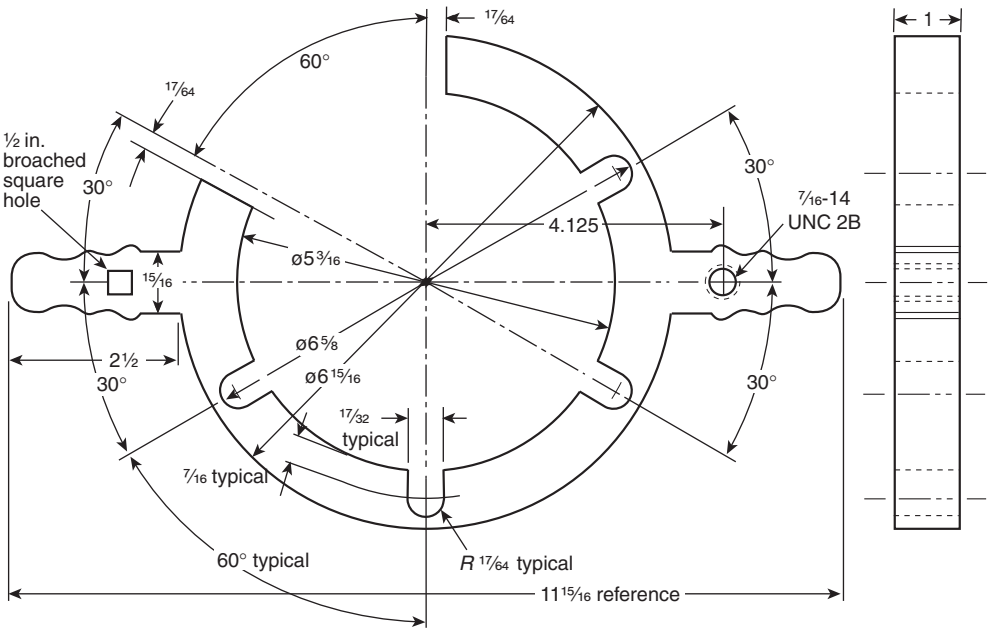
Note: All dimensions are to be the same for similar configurations on the gauge.

FIGURE 6.2.2(b) End View of 5 in. (125 mm) Metal-Face Gauge and Nonthreaded 5 in. (125 mm) Connections.



Notes:
All dimensions are to be the same for similar configurations on gauges.

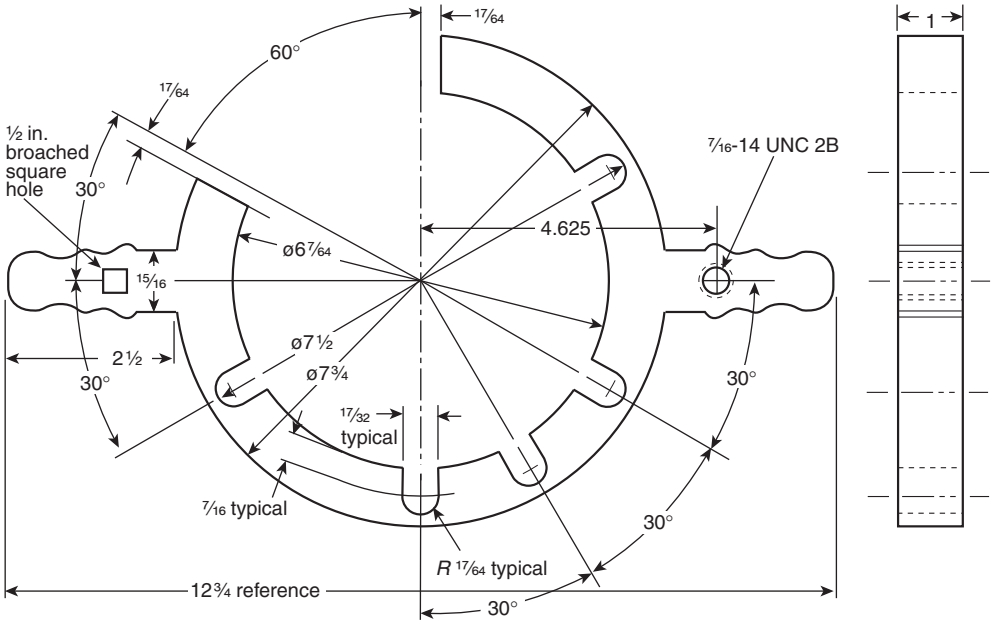
FIGURE 6.2.2(c) End View of 6 in. (150 mm) Metal-Face Gauge and Nonthreaded 6 in. (150 mm) Connections.



Notes:
(1) Use 7/16-14 UNC 2A × 1 in. long hex head cap screw to which to connect torque wrench socket.
(2) Unless otherwise specified, tolerance shall be decimals: X.XXX ± 0.005; fractions: ±1/64.

Drawing units = inches
Angles = ±½ degree
125 micro-inch finish on all machine surfaces.
Do not scale drawing.

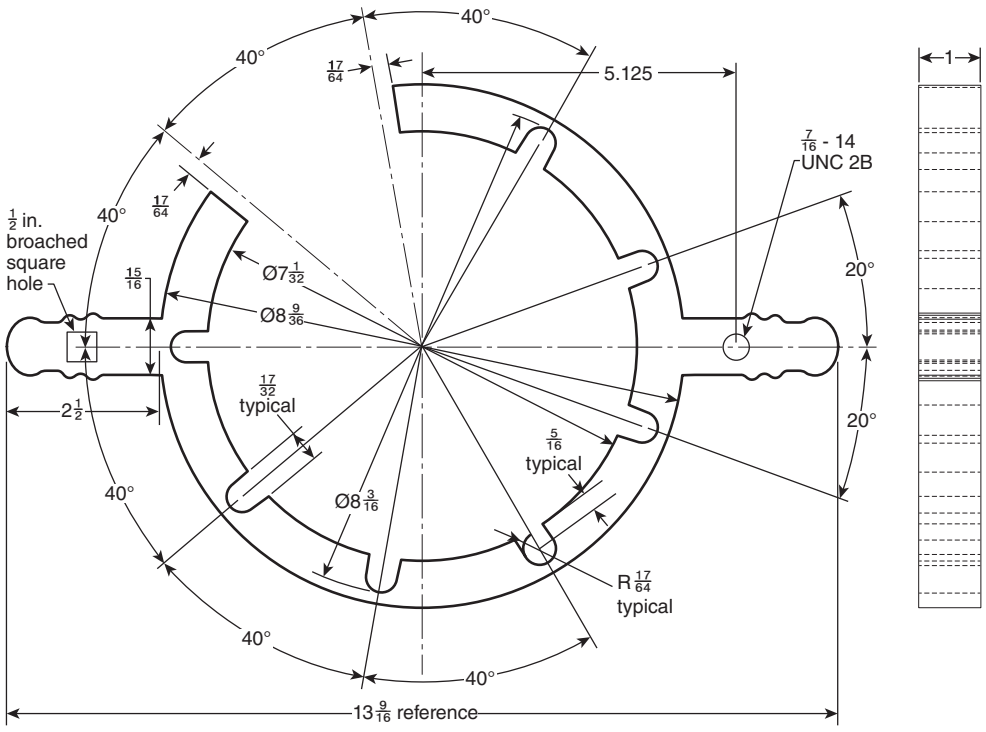
FIGURE 6.5.5.3 Test Wrench for Force to Connect Test of 4 in. (100 mm) Connectors.



Notes:
(1) Use 7/16-14 UNC 2A × 1 in. long hex head cap screw to which to connect torque wrench socket.
(2) Unless otherwise specified, tolerance shall be decimals: X.XXX ± 0.005; fractions: ±1/64.

Drawing units = inches
Angles = ±½ degree
125 micro-inch finish on all machine surfaces.
Do not scale drawing.

FIGURE 6.5.5.4 Test Wrench for Force to Connect Test of 5 in. (125 mm) Connectors.

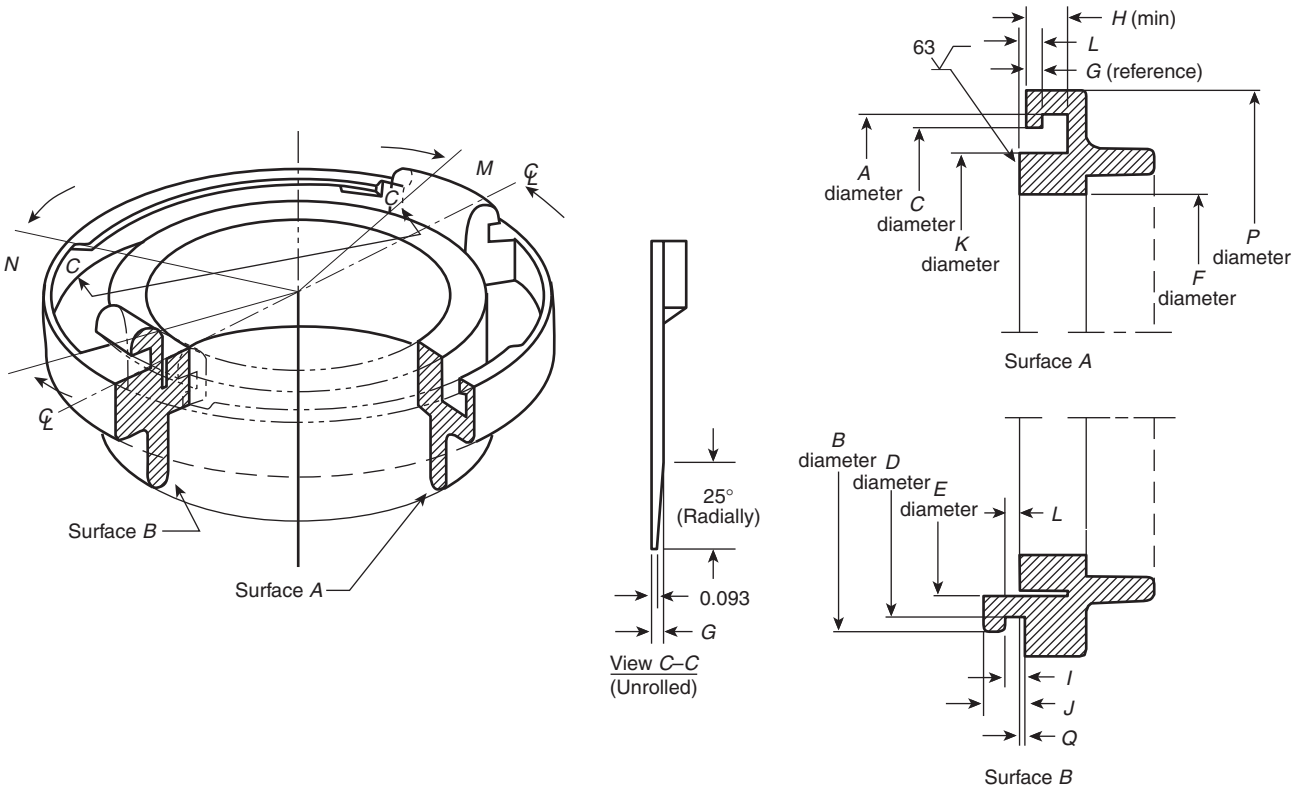


Notes:

(1) Use $\frac{7}{16}$-14 UNC 2A × 1 in. long hex cap screw to which to connect torque wrench socket.
(2) Unless otherwise specified, tolerance should be decimals: X.XXX ± .005; fractions ± $\frac{1}{64}$.

Drawing units = inches
Angles = ± $\frac{1}{2}$ degree
125 micro-inch finish on all machine surfaces.
Do not scale drawing.

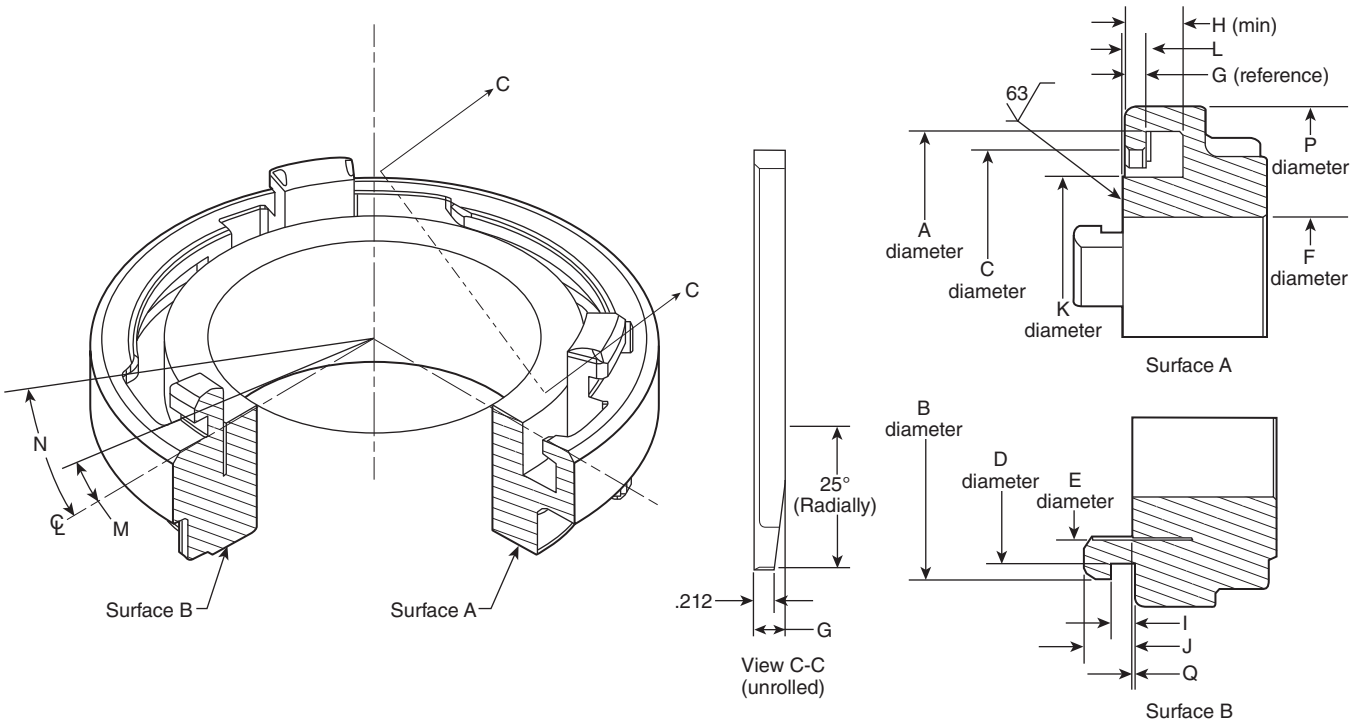
FIGURE 6.5.5.5 Test Wrench for Force to Connect Test of 6 in. (150 mm) Connectors.



Size	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*P*	*Q*
4 in.	5.500	5.472	5.197	5.118	4.528	3.500	0.190	0.576	0.236	0.532	4.500	0.213±.002	15°	35°	6.142	0.023±.002
5 in.	6.957	6.929	6.575	6.496	5.826	4.500	0.220	0.653	0.295	0.622	5.750	0.258±.002	16°	36°	7.717	0.038±.002

Notes:
(1) All linear measurements in inches. Tolerances: X.XXX ± 0.005 in. unless otherwise noted; angles ±½ degree.
(2) Attachment to hydrant or piping to fire department connection — as specified by purchaser.
(3) All dimensions are to be the same for similar configurations on the hydrant or fire department connection.

FIGURE 6.8.2(a) Metal-Faced Hydrant and Fire Department Connections Showing Required Dimensions.



Size	A	B	C	D	E	F	G	H	I	J	K	L	M	N	P	Q
6 in.	7.696	7.576	7.11	7.046	6.342	5.0	0.32	0.902	0.378	0.807	6.276	0.352±.002	10°	22°	8.456	0.026±.002

Notes:

(1) All linear measurements in inches, Tolerances: X.XXX±.005 in. unless otherwise noted.
(2) All dimensions are to be the same for similar configurations on gauges.

FIGURE 6.8.2(b) Metal-Face Hydrant and Fire Department Connections Showing Required Dimensions.

Chapter 7 Gaskets (NFPA 1963)

7.1 Threaded Coupling Gasket.

7.1.1 Each internal connection shall be provided with a resilient thread gasket that does not leak under normal use when fitted accurately in the seat specified in this standard.

7.1.2 Each thread gasket shall meet the dimensions specified in Table 7.1.2.

7.1.3 The durometer of the thread gasket shall be 70 ± 5 Shore A.

7.2 Nonthreaded Connection Gaskets.

7.2.1 Each nonthreaded connection, with the exception of metal-faced hydrants and fire department connections that meet the requirement in Section 6.8, shall be fitted with a resilient face gasket that does not leak under normal use.

7.2.2 The durometer of the gasket shall be 70 ± 5 Shore A.

7.2.3 The face gasket shall be either a suction gasket or a pressure gasket, depending on the application in which the connection is to be used.

Table 7.1.2 Dimensions of Thread Gaskets for Standard Internal Threaded Connections

Nominal Size of Connection (in.)	Inside Diameter		Outside Diameter		Thickness	
	in.	mm	in.	mm	in.	mm
¾	13/16	20.6	1 7/16	36.5	⅛	3.18
1	1 1/16	27	1 7/16	36.5	⅛	3.18
1½	1 9/16	40	2 1/16	52	⅛	3.18
2½	2 9/16	65	3 3/16	81	3/16	4.8
3	3 1/16	78	3¾	95	¼	6.4
3½	3 9/16	91	4⅜	111	¼	6.4
4	4 1/16	103	5⅛	130	¼	6.4
4½	4 9/16	117	5⅞	149	¼	6.4
5	5 1/16	129	6⅜	162	¼	6.4
6	6 1/16	154	7⅛	181	¼	6.4
8	8 1/16	205	9⅛	232	¼	6.4

7.2.3.1 Pressure gaskets shall be designed to withstand the pressure requirements of Sections 4.7 and 4.11 without leakage. They shall be black in color.

7.2.3.2 Suction gaskets shall be designed to allow couplings equipped with the gasket to meet the requirements of Section 4.12. They shall be gray in color.

7.3* Tail Gasket.

7.3.1 Each coupling that is installed on a fire hose with an expansion ring shall be equipped with a resilient gasket of durometer 60 ± 5 Shore A in the hose bowl that keeps the ends of the fabric of the fire hose dry.

7.3.2 The nominal dimensions of these gaskets shall be as follows:

(1) Minimum inside diameter as specified in Table 7.1.2
(2) Outside diameter to accurately fit the recess provided
(3) Thickness 3/16 in. (4.8 mm) minimum

Chapter 8 Use of NH Threads and Nonthreaded Connections (NFPA 1963)

8.1* Hose Coupling Threads.

8.1.1* ¾ in. and 1 in. (19 mm and 25 mm) Hose. All ¾ in. and 1 in. (19 mm and 25 mm) hose shall be provided with couplings having the 0.75-8 NH standard thread and 1-8 NH standard thread, respectively.

8.1.2 1½ in. Through 2 in. (38 mm Through 52 mm) Fire Hose. All 1½ in. through 2 in. (38 mm through 52 mm) fire hose shall be provided with couplings having the 1.5-9 NH standard thread.

8.1.3 2½ in. (65 mm) Fire Hose. All 2½ in. (65 mm) fire hose shall be provided with couplings having the 2.5-7.5 NH standard thread.

8.1.4 3 in. (75 mm) Fire Hose. All 3 in. (75 mm) fire hose shall be provided with couplings having the 2.5-7.5 NH standard thread.

8.1.4.1 Where interchangeability with 2½ in. (65 mm) fire hose is not required, the couplings shall be permitted to have the 3-6 NH standard thread.

8.1.5 3½ in. (90 mm) Fire Hose. All 3½ in. (90 mm) fire hose shall be provided with couplings having the 3.5–6 NH standard thread.

8.1.5.1 Where interchangeability with 3 in. (75 mm) fire hose or other connections is required, the couplings shall be permitted to have the 3-6 NH standard thread.

8.1.6 4 in. (100 mm) Fire Hose. All 4 in. (100 mm) fire hose shall be provided with couplings having the 4-4 NH standard thread.

8.1.6.1 Where interchangeability with 3½ in. (90 mm) fire hose or other connections is required, the couplings shall be permitted to have the 3.5–6 NH standard thread.

8.1.6.2 Where the authority having jurisdiction permits, 4 in. (100 mm) nonthreaded couplings shall be permitted to be used.

8.1.7 4½ in. (114 mm) Fire Hose. All 4½ in. (114 mm) fire hose shall be provided with couplings having the 4.5-4 NH standard thread.

8.1.7.1 Where interchangeability with 4 in. (100 mm) fire hose or other connections is required, the couplings shall be permitted to have the 4-4 NH standard thread.

8.1.8 5 in. (125 mm) Fire Hose. All 5 in. (125 mm) fire hose shall be provided with couplings having the 5-4 NH standard thread.

8.1.8.1 Where interchangeability with 4½ in. (114 mm) fire hose or other connections is required, the couplings shall be permitted to have the 4.5-4 NH standard thread.

8.1.8.2 Where the authority having jurisdiction permits, 5 in. (125 mm) nonthreaded couplings shall be permitted to be used.

8.1.9 6 in. (150 mm) Fire Hose. All 6 in. (150 mm) fire hose shall be provided with couplings having the 6-4 NH standard thread.

8.1.9.1 Where interchangeability with 5 in. (125 mm) fire hose or other connections is required, the couplings shall be permitted to have the 5-4 NH standard thread.

8.1.10 8 in. (200 mm) Fire Hose. All 8 in. (200 mm) fire hose shall be provided with couplings having the 8-4 NH standard thread.

8.1.11 Suction Hose. Suction hose shall be provided with couplings having the NH standard thread compatible with the nominal size of the suction hose.

8.2* Connections for Fire Service Nozzles for Handlines.

8.2.1 Playpipes for connecting shutoff nozzles to 2½ in. (65 mm) fire hose shall have the 2.5-7.5 NH standard thread at the base or primary inlet and the 1.5-9 NH standard thread at the discharge end, as shown in Figure 8.2.1.

8.2.2 Nozzle shutoff valves for either 2½ in. (65 mm) nozzles or 1½ in. (38 mm) nozzles shall have the 1.5-9 NH standard thread for both the inlet and discharge sides of the valve, as shown in Figure 8.2.1 for 2½ in. (65 mm) and Figure 8.2.2 for 1½ in. (38 mm).

8.2.2.1 Where the valve is an integral nondetachable part of a 2½ in. (65 mm) playpipe, the 1.5-9 NH standard thread shall be provided only on the discharge side of the valve.

8.2.3 All nozzles used on booster hose shall have the 1-8 NH standard thread.

8.2.4 All nozzle tips for use on 2½ in. (65 mm) and 1½ in. (38 mm) nozzles shall have the 1.5-9 NH standard thread.

8.2.5* All spray nozzles with a shutoff valve for use on 1½ in. (38 mm) and 2½ in. (65 mm) hose where flows at rated pressure do not exceed 400 gpm (1600 L/min) shall have at least the 1.5-9 NH standard thread at the internal connection.

8.3 Connections for Large-Stream Devices.

8.3.1* 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 the 2.5-7.5 NH standard thread as shown

in Figure 8.3.1(a) and Figure 8.3.1(b). An adapter shall be permitted to be provided to meet this intent.

8.3.2* Subsequent Connections and Nozzles.

8.3.2.1 The discharge end of large-stream devices designed to discharge 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.

8.3.2.1.1 If stacked straight tip nozzles are used, one of the tips shall have the 1.5-9 NH thread as shown in Figure 8.3.1(a).

8.3.2.1.2 Straight tip nozzles and spray nozzles designed to discharge between 400 gpm and 1250 gpm (1600 L/min and 5000 L/min) shall have the 2.5-7.5 NH thread on their inlet.

8.3.2.2 The discharge end of large-stream devices designed to discharge in excess of 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.

8.3.2.2.1 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 8.3.1(b) shall be provided.

8.3.2.2.2 Straight tip nozzles and spray nozzles designed to discharge flows in excess of 1250 gpm (5000 L/min) but less than 3000 gpm (12,000 L/min) shall have the 3.5–6 NH thread on their inlet.

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

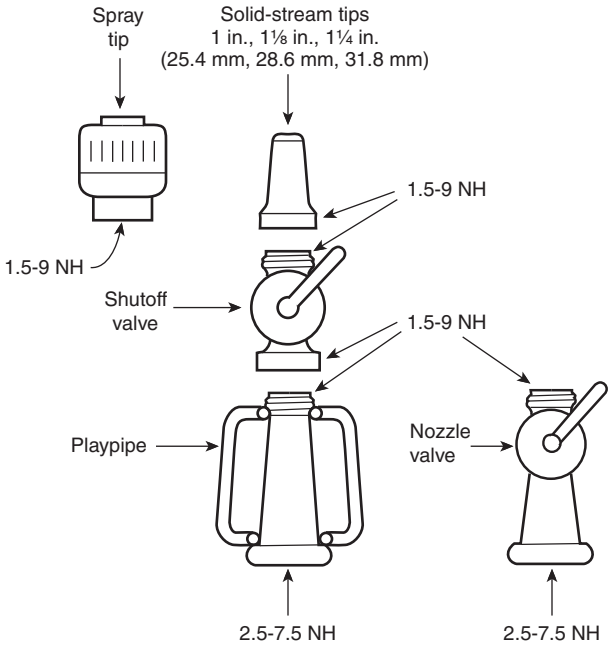


FIGURE 8.2.1 Nozzle Assembly for 2½ in. (65 mm) Hose.

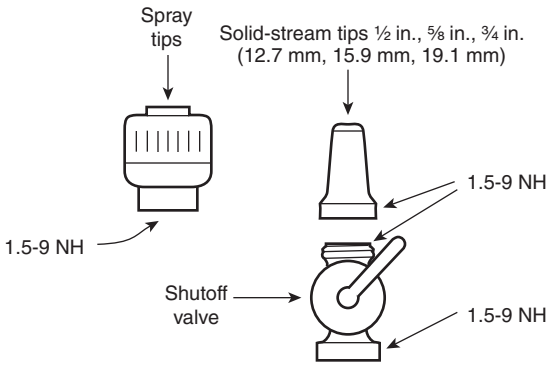


FIGURE 8.2.2 Nozzle Assembly for 1½ in. (38 mm) Hose.

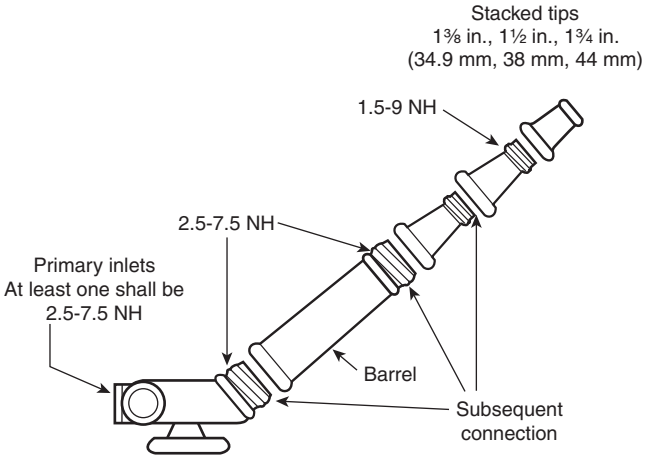


FIGURE 8.3.1(a) Large-Stream Device Rated Under 1250 gpm (5000 L/min).

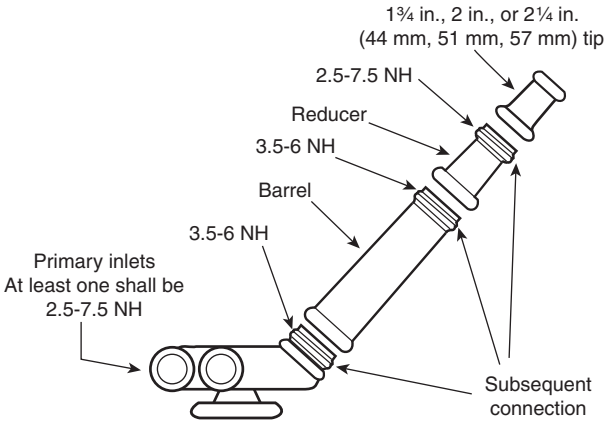


FIGURE 8.3.1(b) Large-Stream Device Rated Over 1250 gpm (5000 L/min) But Less Than 3000 gpm (12,000 L/min).

Chapter 9 Operational Design Requirements (NFPA 1964)

9.1 Administrative

9.1.1* Scope. Chapters 9 through 12 shall cover the requirements for new adjustable-pattern spray nozzles intended for general firefighting use, for marine and offshore platform firefighting 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.

9.1.2 Purpose. The purpose of Chapters 9 through 12 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.

9.1.3* Application. The requirements in Chapters 9 through 12 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 for use on Class A and Class B fires
(3) Portable valves, including gate valves, ball valves, piston valves, butterfly valves, clappered valves, and pressure relief valves
(4) Portable monitors, ladder pipes, and break-apart monitors
(5) Miscellaneous hose appliances, including wyes, siamese, elbows, water curtains, water thieves, and manifolds

9.1.4 Equivalency.

9.1.4.1 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.

9.1.4.2 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

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

9.1.5* Units of Measurement. In this standard, US 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 US or SI units) shall be used throughout.

9.2 Flow Rate Performance.

9.2.1* 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)].

9.2.2 Basic spray nozzles shall flow no less than the rated discharge in at least one position within the range of spray pattern adjustment and no more than the discharge rate specified in 9.2.2.1 through 9.2.2.3 at the rated pressure when tested in accordance with Section 11.1.

9.2.2.1 Basic spray nozzles with a rated discharge of 66 gpm (250 L/min) or less shall flow no less than the rated discharge in at least one position within the range of spray pattern adjustment and no more than 7 gpm (26.5 L/min) over the rated discharge at the rated pressure when tested in accordance with Section 11.1.

9.2.2.2 Basic spray nozzles with a rated discharge greater than 66 gpm (250 L/min) shall flow no less than the rated discharge in at least one position within the range of spray pattern adjustment and no more than 10 percent over the rated discharge at the rated pressure when tested in accordance with Section 11.1.

9.2.2.3 Basic spray nozzles with a rated discharge of 23 gpm (87 L/min) or less shall flow no less than the rated discharge in at least one position within the range of spray pattern adjustment and no more than 3 gpm (11 L/min) over the rated discharge at the rated pressure when tested in accordance with Section 11.1.

9.2.3 Constant gallonage spray nozzles shall flow no less than the rated discharge and no more than the discharge rate specified in 9.2.3.1 through 9.2.3.2 at the rated pressure when tested in accordance with Section 11.1.

9.2.3.1 Constant gallonage spray nozzles with a rated discharge of 66 gpm (250 L/min) or less shall flow no less than the rated discharge and no more than 7 gpm (26.5 L/min) over the rated discharge at the rated pressure when tested in accordance with Section 11.1.

9.2.3.2 Constant gallonage spray nozzles with a rated discharge greater than 66 gpm (250 L/min) 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 11.1.

9.2.4 Constant/select gallonage spray nozzles shall meet the requirements of 9.2.3 at each predetermined discharge rate.

9.2.5 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 11.1.

9.3 Discharge Pattern.

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

9.3.2 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.

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

9.4* Spray Nozzle Controls.

9.4.1 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.

9.4.2 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.

9.4.3 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.

9.4.4 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.

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

9.4.6 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 11.3.1.

9.4.7 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 11.3.2 and 11.3.4.

9.4.8* 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.

9.4.9 Full-Time Swivel.

9.4.9.1 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 11.3.3.

9.4.9.2 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 9.4.7.

9.5 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.

9.6 Flushing. All spray nozzles shall be designed to clear or flush the size of debris specified in Table 9.6 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.

9.6.1 Nozzles shall be tested in accordance with Section 6.2 to verify compliance with Section 9.6.

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

Table 9.6 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

9.7 Fire Hose Appliance Characteristics.

9.7.1* Maximum Operating Pressure. The maximum operating pressure shall be a minimum of 175 psi (12 bar).

9.7.2 Appliance Connectors.

9.7.2.1 All fire hose couplings on the appliance shall meet the applicable requirements of NFPA 1960.

9.7.2.2* All fire hose connectors on an appliance shall conform to the applicable requirements of NFPA 1960. If the hose threads or connectors used by the fire department do not conform to the applicable requirements of NFPA 1960, the authority having jurisdiction shall be permitted to designate the hose threads or connectors that shall be used.

9.7.2.3 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 11.6.

9.7.3 Manually Operated Shutoff Valves.

9.7.3.1 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.

9.7.3.2 If an appliance has more than two valves with lever-operated handles, the two outside handles shall indicate their closed position as described in 9.7.3.1.

9.7.3.2.1 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 either between the 2 and 4 o'clock positions, or between the 8 and 10 o'clock positions when viewed from the single hose connection side.

9.7.3.2.2 Any valve arranged as permitted in 9.7.3.2.1 shall be permanently marked to indicate the open and closed positions.

9.7.3.3 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.

9.7.3.4 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 9.4.5.

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

9.7.4* Relief Valves. If the appliance has a relief valve, the relief valve shall meet the requirements of 9.7.4.1 through 9.7.4.4.

9.7.4.1 The relief valve shall be on the intake side of the shutoff valve.

9.7.4.2 The relief valve shall relieve to atmosphere.

9.7.4.3 The relief valve shall be field adjustable.

9.7.4.4 The manufacturer shall mark the range of pressure adjustment on the relief valve.

9.7.5 Portable Monitors.

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

9.7.5.2 Portable ladder pipes shall have rung attachment mechanisms with multiple motion-locking devices.

9.7.5.3 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.

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

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

9.7.5.6 Any shutoff valves incorporated in a monitor shall meet the requirements of 9.7.3.

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

9.7.5.8 Force to Operate.

9.7.5.8.1 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 11.12.

9.7.5.8.2 The force to elevate the stream of a monitor shall be not more than 40 lbf (180 N) when measured as defined in Section 11.13.

9.7.5.8.3 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 11.14.

9.8 Leakage — Nozzles. Nozzles equipped with a shutoff shall not develop in excess of 12 drops/min (½ mL/min) through the discharge orifice when tested according to Section 11.5.

9.9 Leakage — Fire Hose Appliances.

9.9.1 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 11.4.

9.9.2 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 11.4.

9.10 Rough-Handling Tests for Handline Nozzles.

9.10.1 Handline nozzles shall be capable of continued operation after being subjected to the rough-handling tests in Section 11.10.

9.10.2 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.

9.10.3 All nozzle functions such as pattern selection, flush, flow rate adjustment, and shutoff shall operate as described in Section 9.4. The operating force shall not increase more than 10 percent from that allowed before the test.

9.10.4 Following performance of the test in 9.10.3, samples shall again be subjected to the leakage test defined in Section 9.8. The leakage shall not increase by more than 10 percent from that allowed before the test.

9.11 Rough-Handling Tests for Master Stream Nozzles.

9.11.1 Master stream nozzles shall be capable of continued operation after being subjected to the rough-handling tests in Section 11.11. This requirement shall not apply to flange-mounted nozzles.

9.11.2 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.

9.11.3 All nozzle functions such as pattern selection, flush, flow rate adjustment, and shutoff shall operate as described in Section 9.4. The operating force shall not increase more than 10 percent from that allowed before the test.

9.12 Rough-Handling Tests for Fire Hose Appliances.

9.12.1 Section 9.12 shall not apply to portable monitors.

9.12.2 The appliance shall be capable of operation after being subjected to the rough usage tests in 11.11.4.

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

9.12.4 Following performance of the test to confirm compliance with 9.12.3, the test sample shall again be subjected to the leakage test defined in Section 11.4.

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

9.13 Rough-Handling Tests for Portable Monitors.

9.13.1 The monitor shall remain operational and not leak or come apart after being subjected to the rough usage test described in 11.11.5.

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

9.13.3 Following performance of the test to confirm compliance with 9.13.2, the test sample shall again be subjected to the leakage test described in Section 11.4.

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

9.14 Handholds, Handgrips, and Ladder Hooks.

9.14.1 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 11.18.

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

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

9.15 Connections for Large-Stream Devices.

9.15.1* 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 9.15.1(a) and Figure 9.15.1(b). An adapter shall be permitted to be provided to meet this intent.

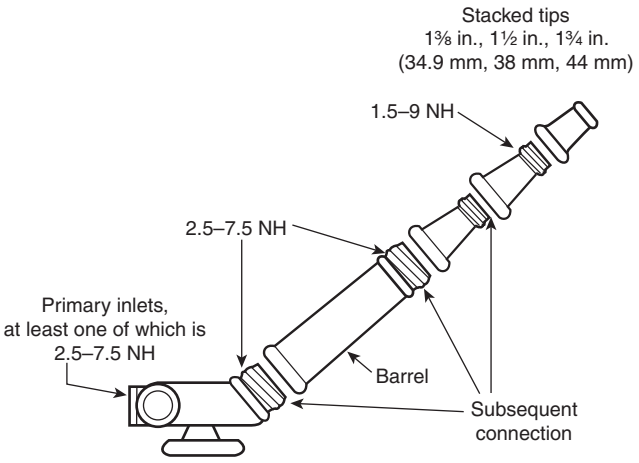


FIGURE 9.15.1(a) Large-Stream Device Rated from 400 gpm to 1250 gpm (1600 L/min to 5000 L/gpm).

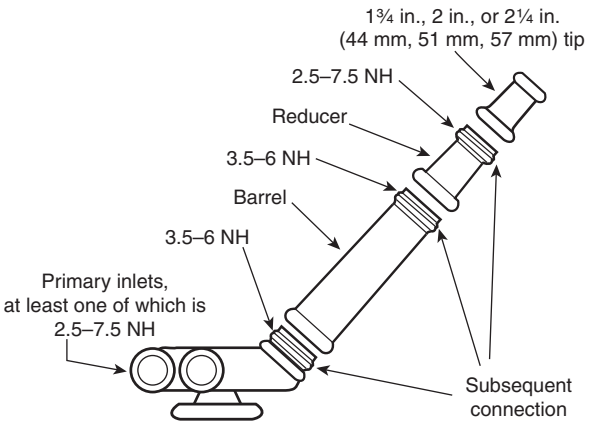


FIGURE 9.15.1(b) Large-Stream Device Rated More Than 1250 gpm (5000 L/min) but Less Than 3000 gpm (12,000 L/min).

9.15.2* Subsequent Connections and Nozzles.

9.15.2.1 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.

9.15.2.1.1 If stacked straight-tip nozzles are used, one of the tips shall have the 1.5–9 NH thread as shown in Figure 9.15.1(a).

9.15.2.1.2 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.

9.15.2.2 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.

9.15.2.2.1 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 9.15.1(b) shall be provided.

9.15.2.2.2 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.

9.15.2.3 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.

9.16 Markings — Nozzles.

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

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

9.16.2 All markings of pressure or flow shall be permitted to be in either US or SI units.

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

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

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

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

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

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

9.17 Markings — Fire Hose Appliances.

9.17.1 Each fire hose appliance shall be permanently identified with the following information using numerals and letters not less than $^{3}/_{16}$ 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

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

9.17.3 The rated flow of the portable monitor shall be near the marking of the maximum operating pressure.

9.18 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.

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

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

9.18.3 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

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

9.18.5 Salt Spray Resistance.

9.18.5.1 Nozzles on Vessels on Saltwater Routes.

9.18.5.1.1 When nozzles are tested for corrosion resistance in accordance with Section 10.3 and Section 11.15, 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.

9.18.5.1.2 Nozzles shall be permanently marked "Marine."

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

9.18.6* Nozzle Rating.

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

9.18.6.1.1 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.

9.18.6.1.2 The rated pressure shall be the minimum nozzle pressure necessary to separately accomplish all of the requirements of 9.18.6.1.2.1 through 9.18.6.1.2.3.

9.18.6.1.2.1 The spray pattern shall be adequately developed to meet the performance requirement of 9.3.3.

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

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

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

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

9.18.6.2.2 The rated pressure shall be the minimum nozzle pressure necessary to separately accomplish all of the requirements of 9.18.6.2.2.1 through 9.18.6.2.2.3.

9.18.6.2.2.1 The spray pattern shall be adequately developed to meet the performance requirement of 9.3.3.

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

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

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

9.18.7.1 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 9.18.7.

9.18.7.2* Nozzles manufactured under a quality control program approved by the AHJ shall not be required to meet 9.18.7.

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

Chapter 10 Construction Materials (NFPA 1964)

10.1 Hydrostatic Strength.

10.1.1 Nozzles and appliances shall be designed to withstand a hydrostatic pressure of four times the maximum rated pressure.

10.1.2 The hydrostatic strength shall be confirmed by testing in accordance with Section 11.7.

10.2 High- and Low-Temperature Exposure. The dry nozzle or appliance shall be capable of operation with 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 Sections 11.8 and 11.9.

10.3* Corrosion Exposure.

10.3.1 After the corrosion exposure, the nozzle shall then be tested for any leakage in accordance with Sections 9.8 and 9.9.

10.3.2 All nozzles and appliances shall be capable of operation after they have been subjected to a salt spray test in accordance with Section 11.15.

10.3.3 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.

10.4 Ultraviolet Light and Water Exposure of Nonmetallic Components.

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

10.4.2 If the nozzle or appliance has exposed nonmetallic parts, it shall be tested as described in Section 11.16.

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

10.4.4 All functions such as pattern selection, flush, flow rate adjustment, and shutoff shall continue to meet the requirements in Section 9.4.

10.5 Aging Exposure of Nonmetallic Components.

10.5.1 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 11.17.

10.5.2 The nozzle shall then meet the rough usage requirements in Section 9.10 for handline nozzles or Section 9.11 for master stream nozzles.

10.5.3 The appliance shall then be subjected to a rough usage test in accordance with 11.11.4 if the appliance is not a portable monitor or in accordance with 11.11.5 if the appliance is a portable monitor.

10.6 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 11.19.

10.7 Rubber Sealing Materials.

10.7.1 A rubber material or synthetic elastomer used to form a seal shall have the properties described in 10.7.1.1 through 10.7.1.4 in the as-received condition.

10.7.1.1* 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 11.20.

10.7.1.2 Material other than silicone rubber shall have a tensile strength of not less than 1500 psi (10.3 MPa) and at least 150 percent ultimate elongation, determined in accordance with Section 11.20.

10.7.1.3 The rubber material or synthetic elastomer shall have a tensile set of not more than 19 percent, determined in accordance with 11.20.1.

10.7.1.4 Compression Sets.

10.7.1.4.1 For nozzles, the rubber material or synthetic elastomer shall have a compression set of not more than 15 percent, determined in accordance with Section 11.21.

10.7.1.4.2 For appliances, a compression set of the material shall not be more than 25 percent, determined in accordance with Section 11.21.

10.7.2 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 11.22.

Chapter 11 Test Methods (NFPA 1964)

11.1 Flow Rate Test.

11.1.1 Test Equipment — Nozzles.

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

11.1.1.2 When testing nozzles, the waterway diameter of the piezometer ring shall be not greater than twice the inlet diameter of the nozzle and not less than the inlet diameter of the nozzle.

11.1.1.2.1 A tapered adapter shall be used to join a piezometer ring with a larger waterway diameter to a nozzle with a smaller waterway diameter.

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

11.1.2 Test Procedure — Nozzles.

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

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

11.1.2.3 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 11.1.2.2 for each of the pattern settings.

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

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

11.1.2.5.1 The nozzle pressure shall be adjusted as specified in 11.1.2.2 for each discrete flow rate selection.

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

11.1.2.6 Constant pressure (automatic) spray nozzles shall be tested on the same equipment specified in 11.1.1.

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

11.1.2.6.2 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.

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

11.1.2.6.4 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.

11.2 Flush Test — Nozzles.

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

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

11.2.2.1 For nozzles with discharge rates up to 60 gpm (230 L/min), a $\frac{1}{8}$ in. (3.18 mm) steel ball shall be used.

11.2.2.2 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.

11.2.2.3 For nozzles with discharge rates greater than 150 gpm (570 L/min), a $\frac{1}{4}$ in. (6.35 mm) steel ball shall be used.

11.3 Control Tests.

11.3.1 Lever-Type Controls — Nozzles.

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

11.3.1.1.1 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.

11.3.1.1.2 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.

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

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

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

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

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

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

11.3.2 Rotational Pattern Control — Nozzles.

11.3.2.1 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).

11.3.2.2 A length of twine or string, not to exceed $\frac{3}{32}$ 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.

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

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

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

11.3.2.4 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.

11.3.2.5 The pattern sleeve shall be rotated from the straight stream position to the wide spray position, and vice versa.

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

11.3.3 Full-Time Swivel — Nozzle.

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

11.3.3.2 A length of twine or string, not to exceed $\frac{3}{32}$ 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.

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

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

11.3.4 Twist Shutoff — Nozzles.

11.3.4.1 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.

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

11.3.4.3 The force gauge shall be used to twist the shutoff to the fully open position, following the method outlined in 11.3.2.2 through 11.3.2.4.

11.3.4.4 The windings on the pattern sleeve shall be reversed, and the force gauge used as described in 11.3.2.4 to rotate the shutoff from the fully open to the fully closed position.

11.3.4.5 In the fully closed position, any leakage shall be measured and not exceed that allowed by Section 9.8.

11.3.5 Test of Handles on Manually Operated Shutoff Valves/Appliances.

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

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

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

11.3.5.4 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 recorded.

11.3.5.5 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.

11.3.5.5.1 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).

11.3.5.5.2 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.

11.3.5.6 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.

11.3.5.7 The maximum force measured in both directions shall be recorded.

11.3.5.8 The valve shall be fully closed without any inlet pressure on the valve.

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

11.3.5.10 The maximum force measured in both directions shall be recorded.

11.4 Leakage Test — Appliances.

11.4.1 The appliance shall be connected to a source of water.

11.4.2 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.

11.4.3 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.

11.4.4 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.

11.4.5 The leakage, if any, shall be measured.

11.5 Leakage Test — Nozzles.

11.5.1 Nozzles equipped with a shutoff shall be connected to a source of water.

11.5.2 Any air shall be bled from the nozzle.

11.5.3 The shutoff valve shall be closed.

11.5.4 Pressure shall be increased to 800 psi (55.2 bar) or one and one-half times the rated pressure, whichever is higher.

11.5.5 Pressure shall be held for 3 minutes.

11.5.6 Any leakage through the discharge orifice during the 3 minutes for which pressure is held shall be measured.

11.5.7 Leakage exceeding 12 drops per minute (½ mL/min) shall constitute failure.

11.5.8 Leakage through any part of the nozzle other than the discharge orifice shall constitute failure.

11.6 Full-Time Swivel — Appliances.

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

11.6.2 The appliance shall be mounted in a device capable of holding the appliance stationary.

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

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

11.6.5 The force shall be recorded.

11.7 Hydrostatic Test.

11.7.1 Hydrostatic Pressure.

11.7.1.1 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.

11.7.1.2 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.

11.7.2 All air shall be bled out of the system.

11.7.3 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.

11.7.4 This maximum pressure shall be held for 1 minute without rupture.

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

11.7.6 Increase in leakage through the discharge orifice of nozzles shall be permitted beyond that allowed in Section 9.8.

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

11.8 High-Temperature Tests.

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

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

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

11.9 Low-Temperature Tests.

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

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

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

11.9.4 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 11.10 for handline nozzles or Section 11.11 for master stream nozzles.

11.9.5 Portable monitors shall be tested in accordance with 11.11.5.

11.10 Rough-Handling Tests — Handline Nozzles. Each nozzle shall be subject to the three tests in 11.10.1 through 11.10.3.

11.10.1 Test One.

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

11.10.1.2 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.

11.10.2 Test Two.

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

11.10.2.2 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.

11.10.2.2.1 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.

11.10.2.2.2 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.

11.10.3 Test Three.

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

11.10.3.2 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.

11.10.3.2.1 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.

11.10.3.2.2 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.

11.11 Rough-Handling Test — Master Stream Nozzles.

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

11.11.2 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.

11.11.3 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.

11.11.4 Rough-Handling Test — Appliances.

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

11.11.4.2 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).

11.11.4.3 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).

11.11.5 Rough Usage Test for Portable Monitors.

11.11.5.1 The assembled monitor shall have caps and plugs installed to protect any threaded connection.

11.11.5.2 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.

11.11.5.3 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.

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

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

11.11.5.6 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.

11.11.5.7 The monitor shall be flow tested and shall remain operational and not leak or come apart.

11.12 Force-to-Rotate Test — Monitors.

11.12.1 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.

11.12.2 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.

11.12.3 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.

11.13 Force-to-Elevate Test — Monitors.

11.13.1 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.

11.13.2 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.

11.13.3 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.

11.14 Stability Test for Portable Monitors.

11.14.1 Test Setup.

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

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

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

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

11.14.1.5 The hose supplying the monitor shall be charged and any slack removed from the hose.

11.14.1.6 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.

11.14.1.7 The monitor shall be positioned to discharge the stream at the maximum elevation position.

11.14.2 Test Procedure.

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

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

11.14.2.3 The monitor shall be operated for a minimum of 3 minutes.

11.14.2.4* 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 immediately shut down and the test discontinued.

11.15 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*.

11.16 Ultraviolet Light and Water Test.

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

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

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

11.16.2 Carbon-Arc Lamp Source.

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

11.16.2.2 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.

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

11.16.2.4 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.

11.16.2.5 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).

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

11.16.3 Xenon-Arc Lamp Source.

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

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

11.16.3.3 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).

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

11.16.3.5 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.

11.16.3.6 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).

11.16.3.7 At the conclusion of the test, the components shall be inspected for cracking or crazing.

11.17 Air-Oven Aging Tests.

11.17.1 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.

11.17.2 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.

11.18 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.

11.19 Moist Ammonia–Air Stress Cracking Test.

11.19.1 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.

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

11.19.1.2 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.

11.19.2 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.

11.19.2.1 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.

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

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

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

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

11.20.1 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.

11.20.2 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).

11.20.3 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.

11.20.4 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.

11.21 Compression Set Test.

11.21.1 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.*

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

11.22 Accelerated Aging Test.

11.22.1 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 be stamped on the specimens after the test exposure.

11.22.2 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 12 Compliance Testing (NFPA 1964)

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

12.2 Sample Selection.

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

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

12.2.2.1 The same nozzle or appliance equipped with a shutoff valve(s) that is initially used to evaluate the requirements of Section 9.4 shall be used for the rough-handling evaluation *(see Section 9.10 and Section 9.11).*

12.2.2.2 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 10.2)* with the high-temperature exposure evaluation done first.

12.2.3 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.

12.3 Test Results.

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

12.3.2 Copies shall be provided when requested by the purchaser.

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

Chapter 13 Ladder Design (NFPA 1931)

13.1 Administration.

13.1.1 Scope.

13.1.1.1* Chapters 13 through 16 specify the requirements for the design of fire department ground ladders and for the design verification tests that are to be conducted by the ground ladder manufacturer.

13.1.1.2 The tests specified herein are the responsibility of the ladder manufacturer only and are not to be performed by fire departments.

13.1.2 Purpose.

13.1.2.1* Chapters 13 through 16 provide the manufacturer of fire department ground ladders with a set of performance requirements against which ladders are to be certified to ensure that the ground ladders are reliable and safe to use.

13.1.2.2 It is not the purpose of Chapters 13 through 16 to specify the details of construction.

13.1.2.3 The limitations imposed are for the purpose of providing reasonable safety requirements and establishing test methods.

13.1.3 Application.

13.1.3.1 Chapters 13 through 16 apply to the manufacture of all new ground ladders and multipurpose ladders intended for use by fire department personnel for rescue, firefighting operations, and training.

13.1.3.2* These ladders are not to be used for any other purpose.

13.2 Requirements for All Ground Ladders.

13.2.1 Duty Rating. Ground ladders shall have a duty rating as specified in Table 13.2.1 when raised at a 75½ degree angle of inclination.

13.2.2 Materials of Construction. Materials used in ground ladder construction shall meet the performance requirements of Chapters 13 through 16.

13.2.2.1 All structural components of ground ladders shall be constructed of materials such that the ground ladder maintains at least 75 percent of the strength necessary to pass all test requirements in Chapters 13 through 16 at 149°C (300°F).

13.2.2.2 If varying types of metal are used in the construction of ground ladders, then the metals shall be chosen or finished to reduce electrolytic action.

13.2.2.3 Fiberglass materials shall meet the performance requirements of Chapter 7 of ANSI-ASC A14.5, *American National Standard for Ladders— Portable Reinforced Plastic — Safety Requirements*.

13.2.2.4 Wood components shall meet the requirements of Chapter 5 of ANSI-ASC A14.1, *American National Standard for Ladders — Wood Safety Requirements*.

13.2.2.5 Wood irregularities shall not exceed the following requirements:

(1) The general slope of the grain shall not be steeper than 1 in 15.
(2) Knots shall not appear, except that pin knots in rungs shall be permitted. Pitch and bark pockets shall be permitted, provided that there is not more than one that is 1 mm (1/32 in.) in width, 51 mm (2 in.) in length, and 3 mm (⅛ in.) in depth. Checks shall not be more than 51 mm (2 in.) in length or 3 mm (⅛ in.) in depth.
(3) Splits shall not be more than 51 mm (2 in.) in length or 3 mm (⅛ in.) in depth.
(4) Cracks shall not be permitted.
(5) Compression wood shall not be permitted.
(6) Cross grain shall not be permitted.
(7) Chambers associated with black streaks shall not be permitted.

13.2.3 Ladder Construction.

13.2.3.1 Ground ladders shall be constructed in a manner to ensure that structural and workmanship defects do not exist that result in the structural strength being reduced below the requirements outlined in Chapters 13 through 16.

Table 13.2.1 Ground Ladder Duty Rating

Type	Maximum Load	
	kg	lb
Folding ladders	136	300
Multipurpose ladders	136	300
Pompier ladders	136	300
Combination ladders	340	750
Single and roof ladders	340	750
Extension ladders	340	750

13.2.3.2 Ground ladders shall be constructed in a manner to ensure that sharp edges, burrs in excess of 0.4 mm (1/64 in.), or other defects that cut or tear clothing or skin do not exist.

13.2.3.3 The beams at the tip of each section of an extension ladder or a roof ladder shall be rounded to allow the ladder to slide on irregular surfaces without catching or snagging during placement or operations, except a single ladder, which can have butt spurs on both ends.

13.2.3.4 Butt spurs shall be provided on the butt end of each beam of single ladders and on the butt end of each beam of the base section of extension ladders.

13.2.3.5 Rungs shall not be less than 32 mm (1¼ in.) in diameter except as allowed by 13.2.3.5.1 and 13.2.3.5.2.

13.2.3.5.1 Folding, multipurpose, and pompier ladder rungs shall be excluded from this requirement.

13.2.3.5.2 Swell center rungs on wood ladders shall be permitted to taper to 28.6 mm (1⅛ in.).

13.2.3.6* Rungs shall be uniformly spaced ±3 mm (±⅛ in.) on centers that are between 305 mm and 356 mm (12 in. and 14 in.).

13.2.3.7* The surfaces of rungs that are designed for use while ascending, descending, working, or standing shall be corrugated, serrated, knurled, dimpled, or coated with a skid-resistant material across their entire width.

13.2.4 Ladder Marking.

13.2.4.1 The designated length of the ground ladder shall be marked within 305 mm (12 in.) of the butt of each beam of single ladders and on each beam of the base section of extension ladders.

13.2.4.2 An alphanumeric code and the month and year of manufacture shall be branded or metal-stamped on each ground ladder or stamped on a metal plate that is permanently attached to each ground ladder.

13.2.4.3 All metal ground ladders shall bear the electrical hazard warning label that is shown in Figure 13.2.4.3 on the outside of each beam between 1.37 m and 1.83 m (4½ ft and 6 ft) from the butt.

FIGURE 13.2.4.3 Electrical Hazard Warning Label for Metal Ground Ladders.

13.2.4.4 All fiberglass and wood ground ladders shall bear the electrical hazard warning label that is shown in Figure 13.2.4.4 on the outside of each beam between 1.37 m and 1.83 m (4½ ft and 6 ft) from the butt.

13.2.4.5 All ground ladders shall bear the ladder positioning label, which is shown in Figure 13.2.4.5, between 1.37 m and 1.83 m (4½ ft and 6 ft) from the butt on the outside of both beams.

13.2.4.6 Single ladders that are designed to be asymmetrical shall be permitted to have the label without the word "out" and the directional arrow.

13.2.5 Heat Sensor Labels.

13.2.5.1 All metal and fiberglass ground ladders shall bear heat sensors that are preset for 149°C (300°F) ± 5 percent.

13.2.5.2 Each heat sensor label shall bear an expiration year and wording that indicates that the expiration date is at the end of that year.

13.2.5.3 Heat sensor labels shall be located on the inside of each beam of each section of the ladder immediately below the second rung from the tip of each section and immediately below the center rung of that section.

13.3 Additional Requirements for Single Ladders Only. The design requirements of this section shall apply in addition to the design requirements specified in Section 4.2.

13.3.1* Length.

13.3.1.1 The measured length of a single ladder shall be the length of one beam, excluding any butt spur.

13.3.1.2 The actual measured length shall be permitted to be 150 mm (6 in.) shorter than the designated length.

13.3.2 Width. The minimum inside width between beams for single ladders shall be 406 mm (16 in.).

13.4 Additional Requirements for Roof Ladders Only. The design requirements of this section shall apply in addition to the design requirements specified in Sections 13.2 and 13.3.

13.4.1 Ladders with double-tapered beams shall not be used in roof operations.

13.4.2 Folding Roof Hook Assemblies.

13.4.2.1* Folding roof hooks shall be provided on all roof ladders.

13.4.2.2 The roof hooks shall be directionally spring-locked and shall have tapered points to reduce slippage.

13.4.2.3 The roof hooks shall meet the design verification tests of Section 15.3 and have a minimum opening of not less than 150 mm (6 in.), measured perpendicular from the outside of the beam to the point.

13.4.3 Length.

13.4.3.1 The measured length of a roof ladder shall be the length of one beam, excluding any butt spur.

13.4.3.2 The measured length shall be permitted to be up to 150 mm (6 in.) shorter than the designated length.

13.5 Additional Requirements for Extension Ladders Only. The design requirements of this section shall apply in addition to the design requirements specified in Section 4.2.

13.5.1 Construction.

13.5.1.1 Extension ladders shall be constructed with a permanently affixed stop that is installed by the manufacturer.

13.5.1.1.1 The stop shall prevent ladders from overextending.

FIGURE 13.2.4.4 Electrical Hazard Warning Label for Fiberglass and Wood Ground Ladders.

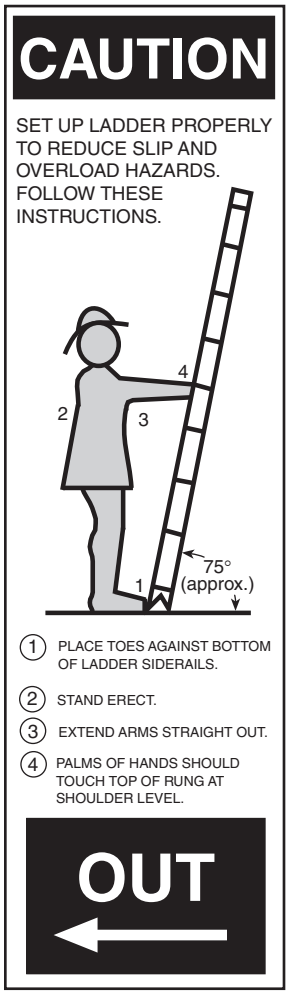


FIGURE 13.2.4.5 Ladder Positioning Label.

13.5.1.1.2 The manufacturer shall determine the location of this permanently affixed stop to ensure that the test requirements of Chapters 13 through 16 are met when the ladder is extended to maximum extended length.

13.5.1.2 Extension ladders shall not be constructed in a manner or method that necessitates the elimination of a rung on any section.

13.5.1.3 One of the lower two rungs of the fly section of an extension ladder shall be permitted to be replaced by the steel cross bar of a halyard-actuated rung lock system.

13.5.1.4 Extension ladders shall be constructed in a manner such that the rungs of each section align with the rungs of other sections when the ladder is extended and pawls are engaged.

13.5.2* Length.

13.5.2.1 The measured length of an extension ladder shall be the maximum extended length along the beams on one side, excluding any butt spur.

13.5.2.2 The measured length of an extension ladder shall be permitted to be up to 150 mm (6 in.) shorter than the designated length.

13.5.2.3 Attic extension ladders shall not exceed 4.9 m (16 ft) in length.

13.5.3 Width.

13.5.3.1 Extension ladders shall have a minimum inside width between beams on any section of at least 406 mm (16 in.).

13.5.3.2 Attic extension ladders shall be permitted to have a minimum inside width between beams on any section of not less than 190 mm (7½ in.).

13.5.4 Hardware.

13.5.4.1 Hardware shall meet the minimum strength requirements of the ground ladder's component parts.

13.5.4.2 Hardware shall be corrosion resistant or protected against corrosion.

13.5.5 Halyard and Pulley.

13.5.5.1 Extension ladders more than 4.9 m (16 ft) in designated length shall be equipped with a halyard and pulley system.

13.5.5.2 The pulley shall be attached to the ladder in a manner that allows the rung to meet the test requirement of 15.2.3.

13.5.5.3 The pulley shall not be less than 32 mm (1¼ in.) in diameter, measured at the base of the sleeve.

13.5.5.4 The halyard shall not be less than 9.5 mm (⅜ in.) in diameter and shall have a minimum breaking strength of 374 kg (825 lb). Splices shall not be permitted.

13.5.5.5 On three- and four-section extension ladders, all fly sections beyond the first fly section shall be permitted to be extended by wire rope.

13.5.5.5.1 Such wire rope shall have a 5 to 1 safety factor while supporting 2 times the dead load weight of the fly section(s) that the cable is intended to raise.

13.5.5.5.2 If wire rope is used, a means for adjusting the length of wire rope shall be provided.

13.5.5.5.3 Splices shall not be permitted.

13.5.5.6* If a continuous halyard is used, a secondary means to secure the halyard from the ground prior to climbing shall be provided that is capable of supporting the pull on the halyard in case the pawl disengages while persons are on the ladder.

13.5.6 Pawls.

13.5.6.1 Pawls shall be of a positive, mechanical-action type and shall engage a rung of the supporting section.

13.5.6.2 Pawls shall be fastened or secured to beams in a manner such that vibration and use will not cause bolts and nuts to loosen.

13.5.6.3 Pawls shall be constructed to engage without cutting the rung.

13.5.6.4 The hooks on pawls shall be finished without sharp edges or points.

13.5.6.5 Pawls shall be designed and attached so that they rest on the rungs as near to the beams as possible.

13.5.7 Staypoles.

13.5.7.1 Staypoles shall be furnished on all extension ladders of more than 12.2 m (40 ft) designated length.

13.5.7.2 All staypoles shall be permanently attached to the ground ladder and shall not be removed for ladder nesting.

13.5.7.3 Staypole spikes shall not project beyond the butt of the base section when the extension ladder is in the bedded position.

13.5.7.4 A means shall be provided to hold the staypoles in a secure position against the base section when the staypoles are not in use.

13.5.7.5 A label shall be provided on each staypole.

13.5.7.5.1 The label shall be positioned between 1.37 m and 1.83 m (4½ ft and 6 ft) from the butt of the pole.

13.5.7.5.2 The label shall read as follows:
Place staypoles only when both poles can be placed properly.

13.6 Additional Requirements for Combination Ladders Only. The design requirements of this section shall apply in addition to the design requirements specified in Section 13.2.

13.6.1 Length.

13.6.1.1 The measured length of combination ladders shall be determined in the single or extension configuration and shall be the maximum length along the beams on one side, excluding any butt spur.

13.6.1.2 The measured length shall be permitted to be up to 150 mm (6 in.) shorter than the designated length.

13.6.1.3 The designated length of combination ladders shall not exceed 4.9 m (16 ft).

13.6.2 Width. The minimum inside width between beams for combination ladders shall be 305 mm (12 in.).

13.7 Additional Requirements for Folding Ladders Only. The design requirements of this section shall apply in addition to the design requirements specified in Section 13.2.

13.7.1 Construction.

13.7.1.1 Folding ladders shall be equipped with foot pads that have a nonskid or skid-reducing material on the bottom side of the foot pad.

13.7.1.2 Folding ladders shall have a positive locking device to hold the ladder in the open position.

13.7.2 Length. The measured length of a folding ladder shall be the maximum length along the beam on one side, excluding any foot pad.

13.7.3 Designated Length. The designated length of folding ladders shall not exceed 4.3 m (14 ft).

13.7.4 Width. The minimum inside width between beams for folding ladders in the open position shall be 190 mm (7½ in.).

13.8 Additional Requirements for Pompier Ladders Only. The design requirements of this section shall apply in addition to the design requirements specified in Section 13.2.

13.8.1 Construction.

13.8.1.1 Pompier ladders shall be equipped with a serrated steel hook that is permanently fastened to the center beam of the ladder.

13.8.1.2 Pompier ladders shall be equipped with a minimum of two stand-off brackets, each capable of maintaining a minimum distance of 178 mm (7 in.) between the centerline of the rung and the portion of the bracket that contacts the wall.

13.8.2 Length.

13.8.2.1 The measured length of a pompier ladder shall be the distance measured along the beam from the bottom of the beam to the underside of the horizontal portion of the hook.

13.8.2.2 The measured length of a pompier ladder shall be permitted to be up to 150 mm (6 in.) shorter than the designated length.

13.8.2.3 The designated length of pompier ladders shall not exceed 4.9 m (16 ft).

13.8.3 Width. The minimum overall width of the ladder shall be 305 mm (12 in.).

13.9 Additional Requirement for Multipurpose Ladders Only. The design requirement of this section shall apply in addition to the design requirements of Section 13.2.

13.9.1 ANSI Compliance. Multipurpose ladders shall be compliant with either ANSI-ASC A14.2, *American National Standard for Ladders — Portable Metal — Safety Requirements*, or ANSI-ASC A14.5, *American National Standard for Ladders — Portable Reinforced Plastic — Safety Requirements*, with duty ratings of Type 1A or 1AA.

13.10 Manufacturer Certification.

13.10.1 Ground ladders that meet all of the requirements of Chapters 13 through 16 shall be so certified by the ladder manufacturer.

13.10.2 A label stating that the ground ladder meets the requirements of Chapters 13 through 16 shall be affixed to the ladder.

Chapter 14 Ladder Accessories (NFPA 1931)

14.1 General Requirements.

14.1.1 Ladder accessories shall not interfere with operation of the ladder or inhibit the function of any component parts.

14.1.2 Ladder accessories shall not obstruct existing ladder markings required by 13.2.4.

14.1.3 Installed accessories shall not increase the overall dimensions of ladders.

14.1.4 Ladder accessories shall not cause the ladder to be unbalanced.

14.1.5 Accessories shall meet all of the requirements in this chapter and be certified by the manufacturer of the accessory.

14.1.6 Manufacturers of ladder accessories shall list all ladders for which their accessories have been approved for use by the accessory manufacturer.

14.1.7 The use of ladder accessories other than those on the ladder accessory manufacturer's approved list shall not be permitted.

14.1.8 Ladder accessory manufacturers shall provide service and use instructions for their products, including recommended preventive maintenance checks and schedules and installation and removal instructions.

14.1.9 Ladder accessories shall conform to the appropriate sections of ANSI-ASC A14.8, *American National Standard for Ladders — Safety Requirements for Ladder Accessories.*

14.1.10 Construction of ladder accessories shall meet the requirements of 13.2.3.1 and 13.2.3.2.

14.1.11 Ladder accessories shall not use metals that cause electrolytic action.

14.1.12 Ladder accessories shall not compromise duty rating *(see Table 13.2.1).*

14.1.13 Ladder accessories shall display markings for applicable tests.

14.1.14 Ladder accessories shall not interfere with, obstruct, or compromise any tests required by Chapters 13 through 16 and NFPA 1932.

14.1.15 A ladder accessory found to be defective or damaged shall be removed from service until repaired or replaced in accordance with the accessory manufacturer's instructions.

14.1.16 A ladder compromised by accessory damage shall be tagged as out of service (OSS) until inspected and found in compliance with Chapter 6 of NFPA 1932.

14.1.17 Temporary repairs of compromised ladders shall not be permitted *(see 6.2.2 of NFPA 1932).*

14.1.18 If a ladder accessory(ies) is installed on an existing NFPA-approved ladder, service testing in accordance with Chapter 7 of NFPA 1932 shall be permitted to be performed

without removing the installed ladder accessory(ies) or compromising the ladder's performance.

14.1.19 Ladder accessories and their component parts shall meet the requirements of 13.2.2.

Chapter 15 Design Verification Tests (NFPA 1931)

15.1 Requirements for All Design Verification Tests.

15.1.1 Design verification tests shall be conducted on a representative sample of the longest length of a specific product design during the initial evaluation and shall be repeated thereafter whenever there is a change in the design, method of manufacturing, or material.

15.1.1.1 The design verification tests shall be the responsibility of the manufacturer and shall be performed only on new, unused ladders.

15.1.1.2 Ladders subjected to design verification tests shall be destroyed after testing is completed.

15.1.2 Design verification tests shall not be conducted on ladders that have been in use or have been subjected to prior damage, misuse, or abuse.

15.1.3 Test loads shall remain in place for a minimum of 5 minutes unless otherwise specified in Chapters 13 through 16.

15.1.4 Conformance to the design verification test requirements shall be determined 1 minute after removal of the test load.

15.2 Single, Extension, and Combination Ladder Design Verification Tests.

15.2.1 Horizontal Bending Tests.

15.2.1.1 The ladder shall be positioned for testing and shall be tested as shown in Figure 15.2.1.1.

15.2.1.1.1 The ladder shall be placed in a flat, horizontal position and supported 150 mm (6 in.) from each end of the ladder.

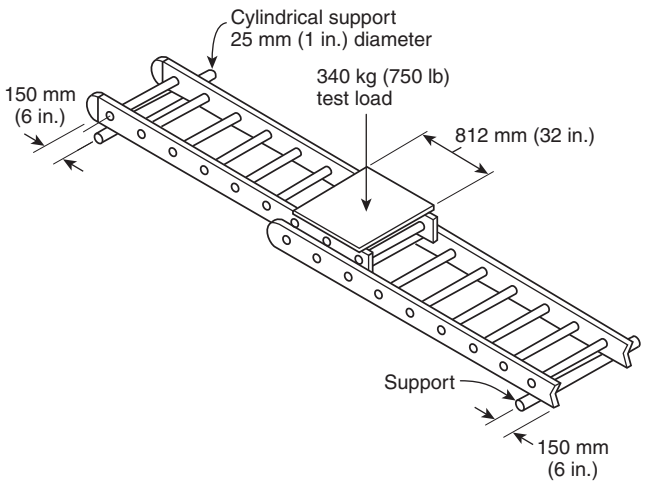


FIGURE 15.2.1.1 Position of Ladder During Design Verification Horizontal Bending Test.

15.2.1.1.2 When extension and combination ladders are tested, the ladder shall be extended to the maximum extended length with pawls engaged.

15.2.1.2 Auxiliary means shall be permitted to be used to ensure that the ladder pawls remain engaged during the test to prevent movement of the fly section relative to the base section during the test.

15.2.1.3 A test load of 340 kg (750 lb) shall be applied equally across the beams of the ladder and 406 mm (16 in.) each side of lengthwise center inclusive.

15.2.1.4 The ladder shall sustain the test load without ultimate failure.

15.2.2 Deflection Test.

15.2.2.1 The ladder shall be positioned for testing and shall be tested as shown in Figure 15.2.2.1.

15.2.2.2 The ladder shall be extended to the maximum extended length and set to an angle of inclination of 75½ degrees.

15.2.2.3 A test load of 227 kg (500 lb) shall be applied to the rung at the vertical center of the ladder adjacent to one of the beams over a span of 89 mm (3½ in.).

15.2.2.4 The butt spur on the beam that is opposite the test load shall remain in contact with the ground or other supporting surface.

15.2.2.5 The test load then shall be reapplied to an area of the rung adjacent to the opposite beam, and the test shall be repeated.

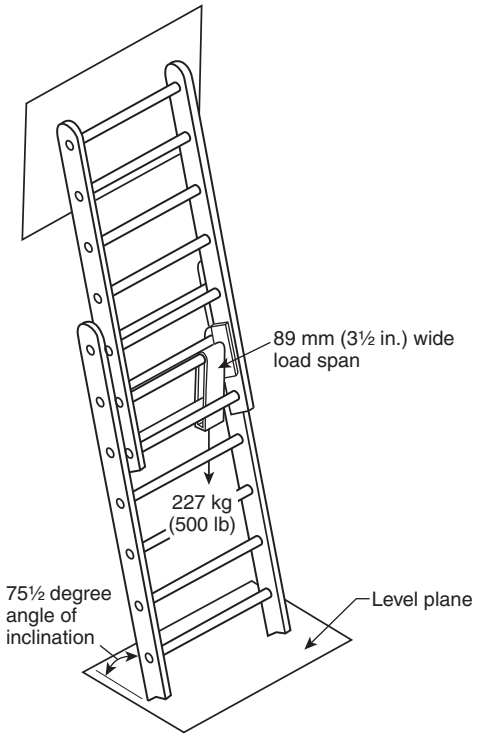


FIGURE 15.2.2.1 Position of Ladder During Design Verification Deflection Test.

15.2.3 Rung-Bending Strength Test.

15.2.3.1 The rung-bending strength test shall be conducted on a test unit that consists of either a single section of the ladder or on a three-rung test sample taken from the maximum width portion of a like ladder section with a like rung.

15.2.3.1.1 The test unit shall be positioned for testing and shall be tested as shown in Figure 15.2.3.1.1.

15.2.3.1.2 The test unit shall be supported and the test load shall be applied using a standard loading block that is located in the center of the rung.

15.2.3.1.3 The rung being tested shall not be braced.

15.2.3.2 A downward test load of 454 kg (1000 lb) shall be applied on the standard loading block.

15.2.3.3 When the test load is removed, the permanent deformation shall be measured with a straight edge and a rule, as shown in Figure 15.2.3.1.1.

15.2.3.4 The permitted permanent deformation shall not exceed $L/50$ for rung length (L), measured between the beams.

15.2.3.5 There shall not be any permanent deformation that is greater than the permitted deformation specified in 15.2.3.4, and there shall not be any other visible damage.

15.2.4 Rung-to-Beam Shear Strength Test.

15.2.4.1 The rung-to-beam shear strength test shall be conducted on a test unit that consists of either a single section of the ladder or on a three-rung test section taken from a like ladder having the same rung cross section and rung joint.

15.2.4.1.1 The test unit shall be positioned for testing and shall be tested as shown in Figure 15.2.4.1.1.

15.2.4.1.2 The test unit shall be set at an angle of inclination of 75½ degrees.

15.2.4.2 A downward test load of 454 kg (1000 lb) shall be applied on the widest like cross section, on both braced and unbraced test rungs, as near the beam as possible.

15.2.4.2.1 If a three-rung test section is used, the test shall be applied to the center rung.

15.2.4.2.2 If single sections of a ladder are tested, the test load shall be applied to the third or fourth rung from the butt.

15.2.4.3 When the test load is removed, the test unit shall show no permanent deformation or ultimate failure either in the fastening means attaching the rung or in the beam.

15.2.5 Rung Torque Test.

15.2.5.1 The rung torque test shall be conducted on a test unit that consists of either a single section of the ladder or on a short test section that comprises at least one rung and two beams.

15.2.5.2 The test unit shall be positioned for testing and shall be tested as shown in Figure 15.2.5.2.

15.2.5.3 A torque test load of 169.5 N·m (1500 in.-lb) shall be applied in a clockwise and then a counterclockwise direction, alternately, for 10 cycles.

15.2.5.4 The rung joint shall be secured to the beams so that the alternating torque load shall not cause relative motion between the rung and the beams in excess of 9 degrees, based on a 1.6 mm (1/16 in.) maximum movement for a 32 mm (1¼ in.) diameter round rung.

15.2.6 Side Sway Test.

15.2.6.1 The side sway test shall be conducted on a test unit that consists of a single ladder, individual sections from an extension ladder, or individual sections from a combination ladder.

15.2.6.1.1 All sections of an extension ladder shall be individually tested.

15.2.6.1.2 Both sections of a combination ladder shall be individually tested.

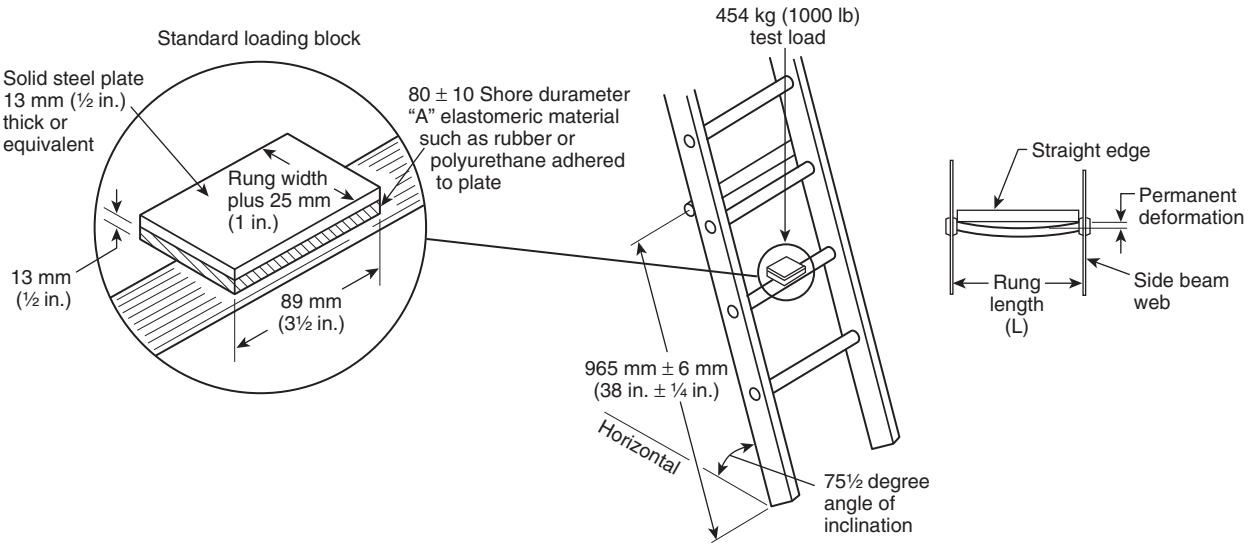


FIGURE 15.2.3.1.1 Design Verification Rung-Bending Test.

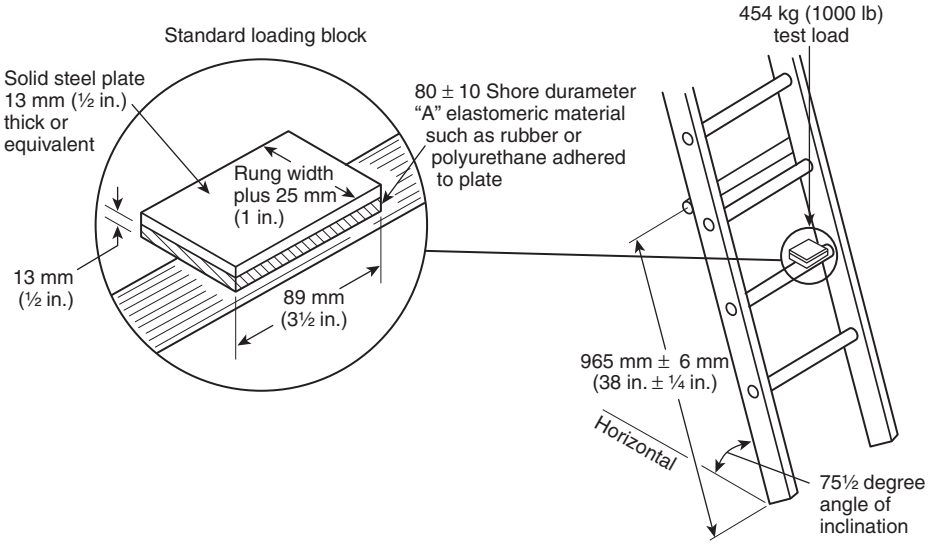


FIGURE 15.2.4.1.1 Design Verification Rung-to-Beam Shear Strength Test.

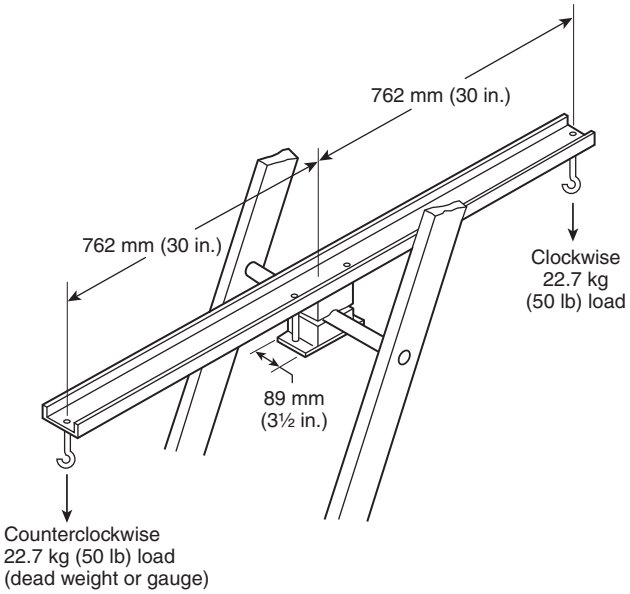


FIGURE 15.2.5.2 Design Verification Rung Torque Test.

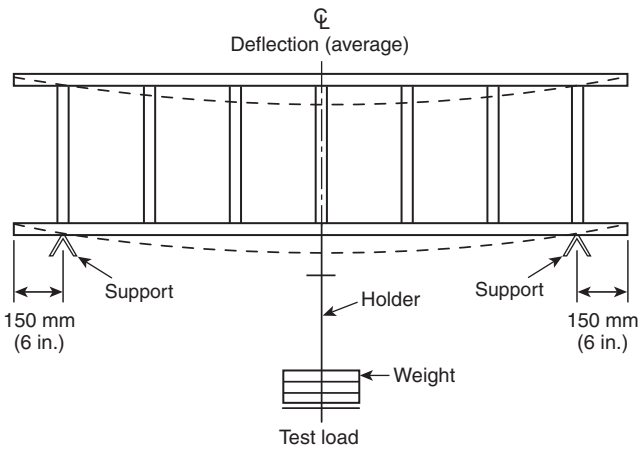
15.2.6.2 The test unit shall be positioned for testing and shall be tested as shown in Figure 15.2.6.2.

15.2.6.2.1 The test unit shall be placed on edge, resting on level supports that are located 150 mm (6 in.) from each end of the ladder.

15.2.6.2.2 The beams shall be in a horizontal plane, and the rungs shall be in a vertical plane and perpendicular to the ground.

15.2.6.3 A preload of 27.2 kg (60 lb) shall be applied at the center of the span over an 89 mm (3½ in.) length of the bottom beam.

15.2.6.4 The preload required in 15.2.6.3 shall be held for a period of 1 minute and then unloaded.



Note: The deflection is the difference between the height of the lower edge of the ladder side when unloaded (solid line) and when loaded (dotted line).

FIGURE 15.2.6.2 Position of Ladder for Design Verification Side Sway Test.

15.2.6.5 A test load of 63.5 kg (140 lb) shall then be applied to the center of the span over an 89 mm (3½ in.) length of the bottom beam.

15.2.6.5.1 The test load shall be applied by hanging weights from the bottom of the lower beam.

15.2.6.5.2 The test load shall be centered with respect to the width of the beam.

15.2.6.6 Each test unit shall withstand this test without any permanent deformation in excess of 1/1000 of the effective span of the beams.

15.2.7 Beam Cantilever Bending Tests.

15.2.7.1 The beam cantilever bending test shall be conducted on a test unit that consists of either a single ladder section or the base section of an extension ladder.

15.2.7.1.1 Any butt spurs affixed to the section shall be removed before the test is conducted.

15.2.7.1.2 The test unit shall be placed on edge with the rungs in a vertical plane.

15.2.7.1.3 The lower beam shall be unsupported from the butt end to the midpoint of the lowest rung.

15.2.7.1.4 The remainder of the lower beam shall be supported and clamped to a surface that has sufficient strength and rigidity so as not to allow a deflection of more than 0.4 mm ($\frac{1}{64}$ in.) at the clamping points during the test.

15.2.7.2 For the cantilever-in bending test, the test unit shall be positioned for testing and shall be tested as shown in Figure 15.2.7.2.

15.2.7.2.1 The test load shall consist of a weight of 385.5 kg (850 lb).

15.2.7.2.2 The test load shall be applied to a block that is 25 mm (1 in.) thick, 51 mm (2 in.) long measured along the beam, and of a width equal to the clear distance between flanges.

15.2.7.2.3 The block shall be positioned such that it rests on the full width of the upper beam at the extreme bottom end of the beam and shall be held in place by a clamp.

15.2.7.2.4 The test load shall be suspended from the clamp so that it is acting through the vertical neutral axis of the beam.

15.2.7.2.5 The allowable permanent deformation of the upper beam shall not exceed 12.7 mm (½ in.).

15.2.7.3 For the cantilever-out bending test, the test unit shall be positioned for testing and shall be tested as shown in Figure 15.2.7.3.

15.2.7.3.1 The test load shall consist of a weight of 385.5 kg (850 lb).

15.2.7.3.2 The test load shall be applied to a block that is 25 mm (1 in.) thick, 51 mm (2 in.) long measured along the beam, and of a width equal to the clear distance between flanges.

15.2.7.3.3 The block shall be positioned such that it rests on the full width of the lower beam at the extreme bottom end of the beam and shall be held in place by a clamp.

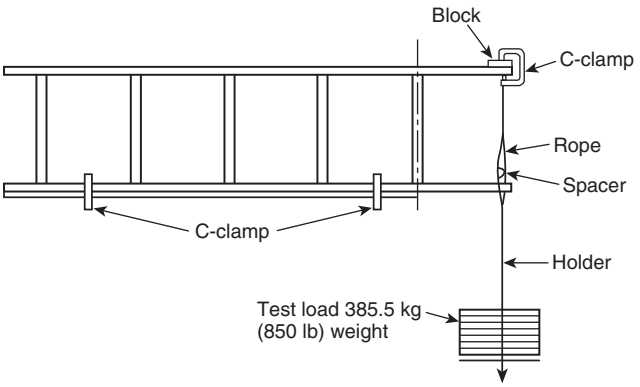


FIGURE 15.2.7.2 Position of Ladder for Design Verification Beam Cantilever-In Bending Test.

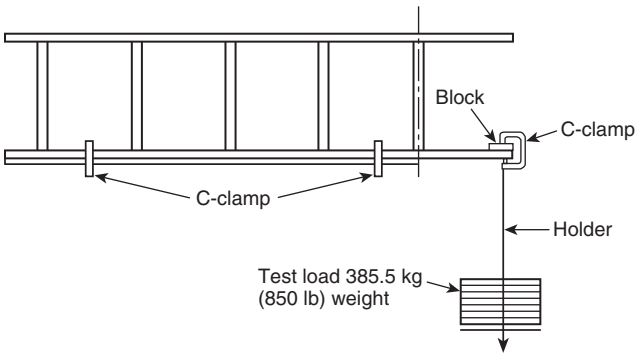


FIGURE 15.2.7.3 Position of Ladder for Design Verification Beam Cantilever-Out Bending Test.

15.2.7.3.4 The test load shall be suspended from the clamp so that it is acting through the vertical neutral axis of the beam.

15.2.7.3.5 The allowable permanent deformation of the lower beam shall not exceed 12.7 mm (½ in.).

15.2.8 Ladder Section Twist Test.

15.2.8.1 The ladder shall be positioned for testing and shall be tested as shown in Figure 15.2.8.1.

15.2.8.1.1 The ladder section twist test shall be conducted on a ladder base section of at least 2.13 m (7 ft) in length, supported over a 2.13 m (7 ft) test span.

15.2.8.1.2 The ladder shall be placed in a flat horizontal position, and support for the ladder on one end shall be fixed.

15.2.8.1.3 The ladder shall be tightly clamped onto the test fixtures during this test.

15.2.8.1.4 The test torque shall be applied by either a torque wrench or test loads that are applied on the end of the arm.

15.2.8.2 A preload of 68 N·m (600 in.-lb) shall be used to establish a reference for angular deflection and shall be applied to the ladder in a clockwise direction for a minimum of 1 minute, after which the ladder shall be unloaded.

15.2.8.3 A test torque of 135 N·m (1200 in.-lb) then shall be applied in a clockwise direction for 5 minutes.

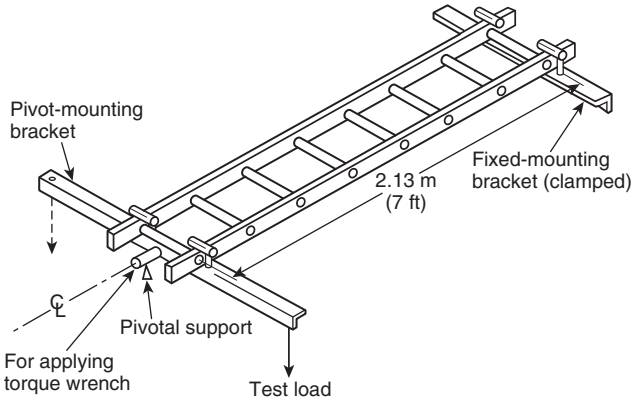


FIGURE 15.2.8.1 Position of Ladder for Design Verification Ladder Section Twist Test.

15.2.8.4 The angle of twist measured from the horizontal position in the clockwise direction shall not be greater than 14 degrees as measured while the load is applied.

15.2.8.5 A preload of 68 N·m (600 in.-lb) then shall be used to establish a reference for angular deflection and shall be applied to the ladder in a counterclockwise direction for a minimum period of 1 minute, after which the ladder shall be unloaded.

15.2.8.6 A test torque of 135 N·m (1200 in.-lb) then shall be applied in a counterclockwise direction.

15.2.8.7 The angle of twist measured from the horizontal position in the counterclockwise direction shall not be greater than 14 degrees as measured while the load is applied.

15.2.9 Butt Spur Slip Test.

15.2.9.1 All butt spurs for single and extension ladders shall be tested for skid resistance.

15.2.9.2 The ladder shall be positioned for testing and shall be tested as shown in Figure 15.2.9.2.

15.2.9.2.1 The test unit shall consist of a 4.9 m (16 ft) extension ladder extended to the maximum extended length and set at an angle of inclination of 75½ degrees.

15.2.9.2.2 The test surfaces shall be A–C plywood, the "A" surface of which shall be presanded using No. 320 fine wet/dry sandpaper.

15.2.9.2.3 The butt of the test unit shall be placed in contact with the "A" surface of the plywood with the grain parallel to the test load.

15.2.9.2.4 The tip of the fly section shall rest against the "A" surface of the plywood with the grain run in a vertical direction.

15.2.9.3 A test load of 227 kg (500 lb) shall be attached to the third rung from the tip of the fly section.

15.2.9.4 A horizontal pulling force of 222.4 N (50 lbf) applied to the bottom of the test unit 25 mm (1 in.) above the test surface shall not cause movement in excess of 6.4 mm (¼ in.) across the test surface.

15.3 Additional Design Verification Tests for Roof Ladders Only. The design verification tests of this section shall be performed in addition to the design verification tests specified in Section 15.2 and in accordance with the design verification testing requirements specified in Section 15.1.

15.3.1 The roof ladder shall be positioned for testing and shall be tested as shown in Figure 15.3.1.

15.3.1.1 The ladder shall be hung solely by the roof hooks in a vertical position from a fixture that is capable of supporting the entire test load and weight of the ladder.

15.3.1.2 The roof hooks shall be supported only by the points of the hooks.

15.3.1.3 The ladder shall be secured in such a manner as to retain the ladder in the test position in order to prevent injury to test personnel if the hooks fail during the test.

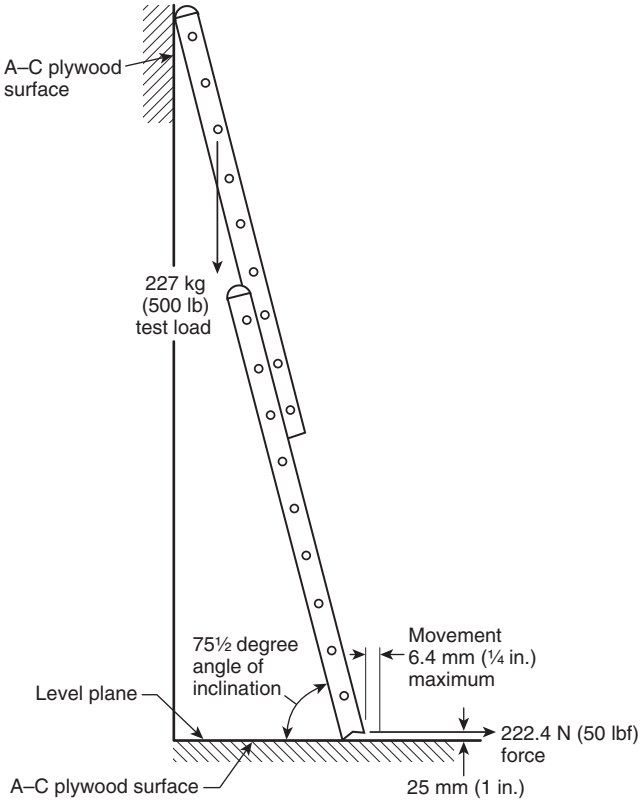


FIGURE 15.2.9.2 Design Verification Butt Spur Slip Test.

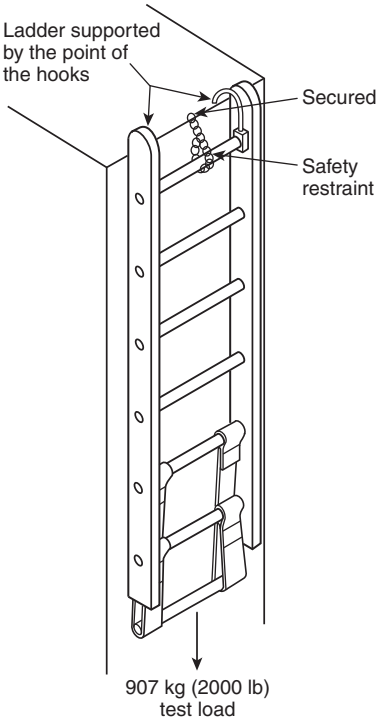


FIGURE 15.3.1 Design Verification Roof Hook Test.

15.3.2 A test load of 907 kg (2000 lb) shall be placed over as many rungs as needed, using weight increments consistent with safety and ease of handling.

15.3.3 The test load shall be applied for a minimum of 1 minute.

15.3.4 Ladder and roof hook assemblies shall sustain this test load with no damage to the structure.

15.3.5 Any deformation to the hooks shall not exceed 5 degrees.

15.4 Additional Design Verification Tests for Extension and Combination Ladders Only. The design verification tests of this section shall be performed in addition to the design verification tests specified in Section 15.2 and in accordance with the design verification testing requirements specified in Section 15.1.

15.4.1 Beam and Hardware Load Test.

15.4.1.1 The beam and hardware load test shall be conducted on a test unit that consists of either the shortest full-size ladder manufactured or of a test section of sufficient length for test purposes.

15.4.1.1.1 If a full-size ladder is used, the fly section shall be extended a minimum of one rung beyond the bedded position.

15.4.1.1.2 Short test sections of extension ladders shall consist of portions of the base and fly sections with all the hardware or fittings attached.

15.4.1.2 The test unit shall be positioned for testing and shall be tested as shown in Figure 15.4.1.2.

15.4.1.2.1 The test unit shall be placed at an angle of inclination of 75½ degrees with both pawls engaged.

15.4.1.2.2 A downward distributed test load of 907 kg (2000 lb) shall be applied to the top rung of the fly section.

15.4.1.3 The test unit shall sustain this test load with no permanent deformation or other visible damage of the beams and hardware.

15.4.2 Single Pawl Load Test.

15.4.2.1 The single pawl load test shall be conducted on a test unit that consists of a single pawl attached in its normal configuration to a length of beam sufficient for test purposes, with the test unit set at an angle of inclination of 75½ degrees.

15.4.2.2 The ladder shall be positioned for testing and shall be tested as shown in Figure 15.4.2.2.

15.4.2.2.1 The pawl shall be engaged over a fixed steel rod of the same diameter as a rung.

15.4.2.2.2 A downward test load of 907 kg (2000 lb) shall be exerted on the end of the beam.

15.4.2.2.3 The beam shall be permitted to be guided to prevent it from turning.

15.4.2.3 The test unit shall sustain this test load without disengagement of the pawl or disengagement of the pawl attachment to the beam.

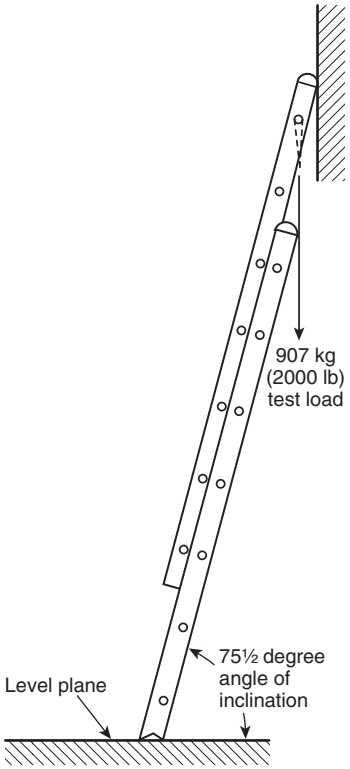


FIGURE 15.4.1.2 Design Verification Beam and Hardware Load Test.

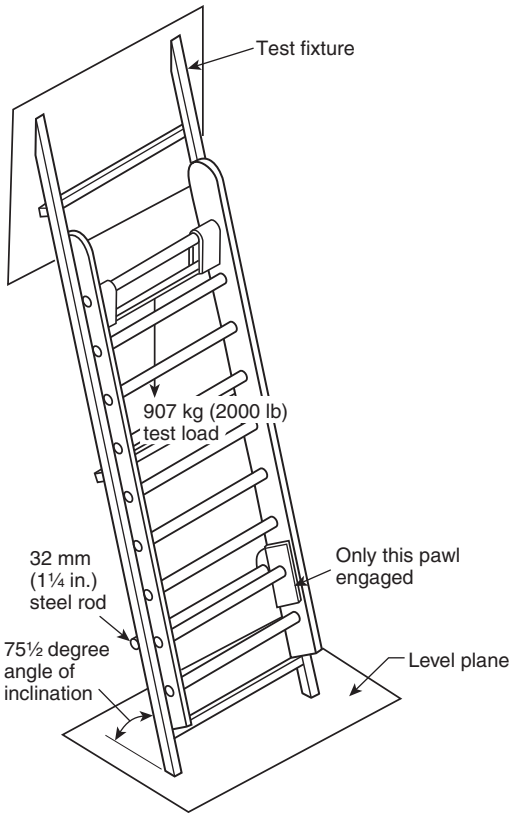


FIGURE 15.4.2.2 Design Verification Single Pawl Load Test.

15.4.3 Pawl Tip Load Test.

15.4.3.1 The pawl tip load test shall be conducted on a test unit that consists of either the shortest full-size ladder manufactured or of a test section of a length sufficient for test purposes.

15.4.3.1.1 If a full-size ladder is used, the fly section shall be extended a minimum of one rung beyond the bedded position.

15.4.3.1.2 Short test sections shall consist of portions of the base and fly sections of the extension ladder with the pawls attached.

15.4.3.2 The test unit shall be positioned for testing and shall be tested as shown in Figure 15.4.3.2.

15.4.3.2.1 The test unit shall be set at an angle of inclination of 75½ degrees with both pawls partially engaged.

15.4.3.2.2 The butt end of the test unit shall be prevented from slipping by a block or equivalent means.

15.4.3.2.3 The tip of each pawl shall bear on the center of a steel test fixture that is placed over the top of a rung.

15.4.3.2.4 During the test, each pawl shall be prevented from pivoting by a means located adjacent to the pivot point of the pawl, but that means of preventing pivoting shall not in any way affect that portion of the pawl under test.

15.4.3.2.5 A downward distributed test load of 907 kg (2000 lb) shall be applied.

15.4.3.3 The test unit and components shall sustain the test load without ultimate failure.

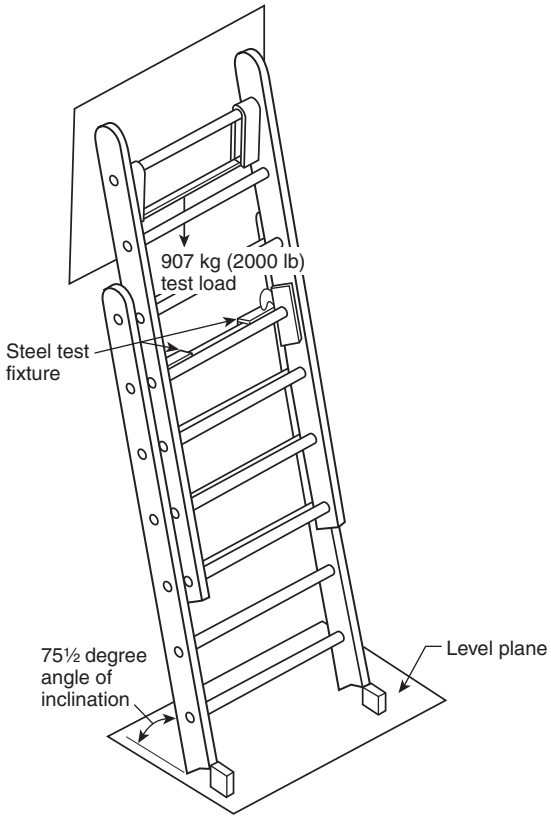


FIGURE 15.4.3.2 Design Verification Pawl Tip Load Test.

15.5 Additional Design Verification Tests for Extension Ladders Only. The design verification tests of this section shall be performed in addition to the design verification tests specified in Sections 15.2 and 15.4 and in accordance with the design verification testing requirements specified in Section 15.1.

15.5.1 Cyclic Rung–Pawl Test.

15.5.1.1 The cyclic rung–pawl test shall not apply to fixed-type or manually operated pawls used on extension ladders or combination ladders.

15.5.1.2 A machine equivalent to that shown in Figure 15.5.1.2(a) shall be used to operate the pawl through the following cycle, as shown in Figure 15.5.1.2(b):

(1) One 150 mm (6 in.) upstroke to allow the pawl to engage the rung
(2) A full 150 mm (6 in.) downstroke to allow the pawl onto the rung
(3) A full 305 mm (12 in.) upstroke to disengage the pawl
(4) A full 305 mm (12 in.) downstroke to return the pawl to the starting position

15.5.1.3 Pawls shall be tested with the ladder set at an angle of inclination of 75½ degrees.

15.5.1.4 The pawl shall be permitted to be manually lubricated prior to or during the test.

15.5.1.5 The stroke speed shall be between 178 mm and 356 mm (7 in. and 14 in.) per second.

15.5.1.6 A minimum of 6000 cycles shall be imposed.

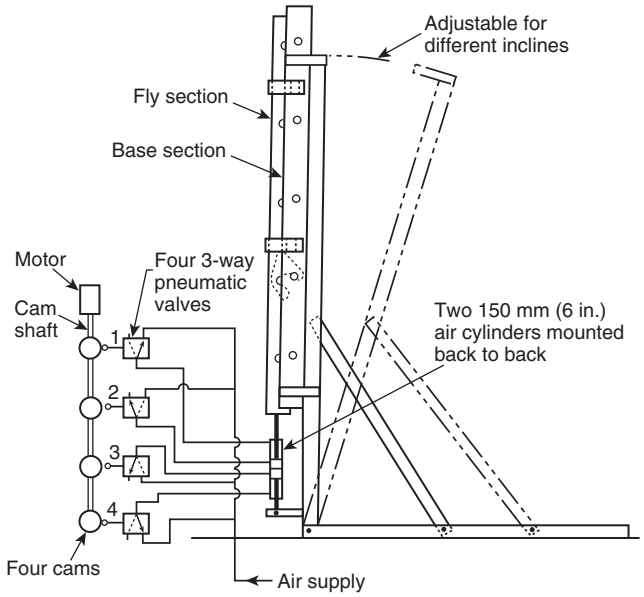


FIGURE 15.5.1.2(a) Design Verification Cyclic Rung–Pawl Test.

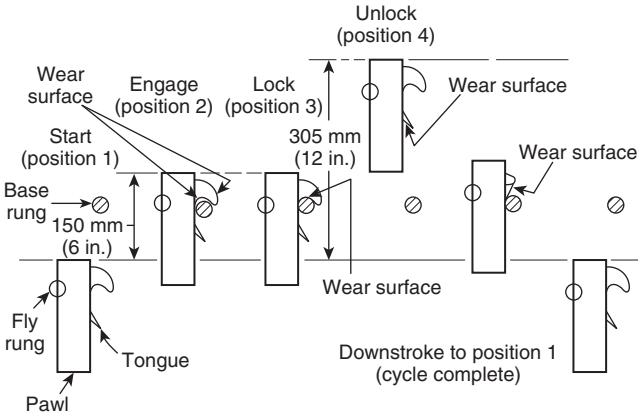


FIGURE 15.5.1.2(b) Design Verification Rung–Pawl Testing Cycle.

15.5.1.7 Any malfunction of the pawl or fracture of its components, including springs, shall be a failure of this test.

15.5.1.8 The presence of wear that does not affect the functioning of the pawl shall not constitute failure.

15.5.2 Multisection Extending Force Test.

15.5.2.1 The multisection extending force test shall be conducted on a complete extension ladder.

15.5.2.1.1 The ladder shall be set at a 90 degree vertical position in the bedded position.

15.5.2.1.2 The base section shall be permitted to be braced or otherwise held to maintain vertical alignment.

15.5.2.2 A measured downward test force shall be applied to the rope if the ladder has a halyard and a pulley system installed.

15.5.2.2.1 The test force shall be smoothly applied to cause vertical extension of the fly section of 610 mm (2 ft) or more, at a rate of between 150 mm and 305 mm (6 in. and 12 in.) per second.

15.5.2.2.2 For those ladders not equipped with a halyard and a pulley, the measured test force shall be applied vertically to the bottom rung of the fly section.

15.5.2.3 The maximum measured test force that occurs during each pull shall be recorded in kilograms (pounds) of pull.

15.5.2.4 Three test pulls shall be done for each ladder, and the maximum forces shall be averaged for the three pulls.

15.5.2.5 The average maximum kilograms (pounds) of pull shall not exceed two times the weight of one of the ladder fly sections.

15.6 Additional Design Verification Tests for Combination Ladders Only.

15.6.1 Testing Requirements. The compression test defined in 15.6.2 shall be performed in addition to the design verification tests specified in Sections 15.2 and 15.4 and in accordance with the design verification testing requirements specified in Section 15.1.

15.6.2 Compression Test.

15.6.2.1 The combination ladder shall be positioned for testing and shall be tested as shown in Figure 15.6.2.1.

15.6.2.2 The ladder shall be tested in its A-frame position, with the test load of 907 kg (2000 lb) applied uniformly to the top rungs.

15.6.2.3 The ladder shall sustain the test load without ultimate failure.

15.7 Design Verification Tests for Folding Ladders Only.

15.7.1 Testing Requirements. The horizontal bending test defined in 15.7.2 shall be performed in accordance with the design verification testing requirements specified in Section 15.1.

15.7.2 Horizontal Bending Test.

15.7.2.1 The ladder shall be positioned for testing and shall be tested as shown in Figure 15.7.2.1.

15.7.2.2 The folding ladder shall be placed in a flat, horizontal position and supported 150 mm (6 in.) from each end.

15.7.2.3 A test load of 136 kg (300 lb) shall be applied at the center of the ladder span and shall be equally distributed across both beams over an area 89 mm (3½ in.) wide.

15.7.2.4 The ladder shall withstand this test without ultimate failure.

15.8 Design Verification Tests for Pompier Ladders Only. The design verification tests of this section shall be performed in accordance with the design verification testing requirements specified in Section 15.1.

15.8.1 The ladder shall be positioned for testing and shall be tested as shown in Figure 15.8.1.

15.8.2 The ladder shall be tested in the vertical hanging position supported only by the hook.

15.8.3 A test load of 907 kg (2000 lb) shall be applied.

15.8.4 The ladder shall sustain this test load without ultimate failure.

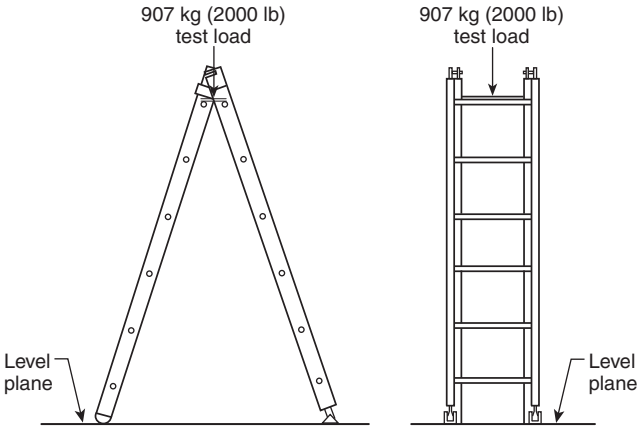


FIGURE 15.6.2.1 Design Verification Combination Ladder Compression Test.

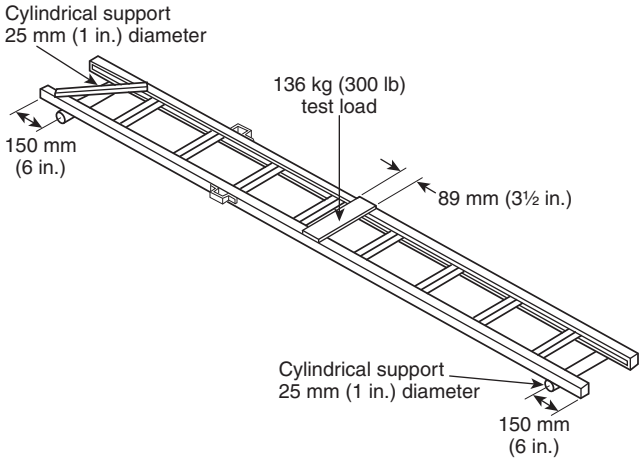


FIGURE 15.7.2.1 Design Verification Folding Ladder Horizontal Bending Test.

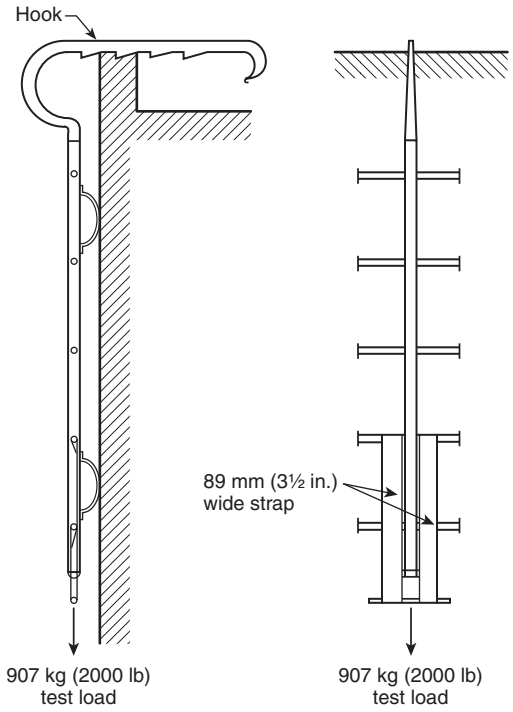


FIGURE 15.8.1 Design Verification Pompier Ladder Test.

Chapter 16 Label Tests (NFPA 1931)

16.1 Labels to Be Tested. All labels required for ground ladders in 13.2.4.3, 13.2.4.4, 13.2.4.5, 13.2.5, 13.5.7.5, and 13.10.2 shall meet the requirements of this chapter.

16.2 Performance Requirements.

16.2.1 Legibility. When tested as specified in 16.3.2, the labels shall retain their original color, readability, and clarity without any darkening, fogging, or blistering.

16.2.2 Adhesion. When tested as specified in 16.3.3.1, the labels shall have an average adhesion of not less than 0.35 N per linear millimeter (2 lbf per linear inch) of label width, and not less than 50 percent of the average adhesion measured for 16.3.3.1 when tested as specified in 16.3.3.2.

16.3 Testing.

16.3.1 Preconditioning.

16.3.1.1 The sample labels shall be applied to a surface material of the same type to which the label will be affixed, and this shall constitute a test sample. The test sample shall be exposed for 72 hours at 23°C ± 1°C (73°F ± 2°F) and 50 ± 2 percent relative humidity.

16.3.1.2 The sample labels shall be applied to a surface material of the same type to which the label will be affixed, and this shall constitute a test sample.

16.3.1.2.1 The test sample shall be exposed for 72 hours to a temperature of 23°C ± 1°C (73°F ± 2°F) and a relative humidity of 50 ± 2 percent.

16.3.1.2.2 The test sample shall then be exposed for 24 hours to a temperature of –40°C (–40°F).

16.3.1.3 The sample labels shall be applied to a surface material of the same type to which the label will be affixed, and this shall constitute the test sample.

16.3.1.3.1 The test sample shall be exposed for 72 hours to a temperature of 23°C ± 1°C (73°F ± 2°F) and a relative humidity of 50 ± 2 percent.

16.3.1.3.2 The test sample shall then be exposed for 6 weeks to a temperature of 60°C ± 2°C (140°F ± 4°F) and a relative humidity of 97 ± 3 percent.

16.3.1.4 The sample labels shall be applied to a surface material of the same type to which the label will be affixed, and this shall constitute the test sample.

16.3.1.4.1 The test sample shall be exposed for 72 hours to a temperature of 23°C ± 1°C (73°F ± 2°F) and a relative humidity of 50 ± 2 percent.

16.3.1.4.2 The test sample shall then be exposed for 90 days of aging at 87°C ± 1°C (190°F ± 2°F) in a mechanical convection air oven.

16.3.1.5 The sample labels shall be applied to a surface material of the same type to which the label will be affixed, and this shall constitute a test sample.

16.3.1.5.1 The test sample shall be exposed for 72 hours to a temperature of 23°C ± 1°C (73°F ± 2°F) and a relative humidity of 50 ± 2 percent.

16.3.1.5.2 The test sample shall then be exposed for 720 hours to ultraviolet light and water.

16.3.1.5.2.1 The ultraviolet light shall be obtained from two stationary, enclosed carbon-arc lamps.

(A) The arc of each lamp shall be formed between two vertical carbon electrodes, 12.7 mm (½ in.) in diameter, located at the center of a revolvable, vertical metal cylinder, 787 mm (31 in.) in diameter and 450.9 mm (17¾ in.) in height.

(B) Each arc shall be enclosed with a borosilicate glass globe.

(C) The samples shall be mounted vertically on the inside of the revolvable cylinder, facing the lamps, and the cylinder shall continuously revolve around the stationary lamps at 1 rpm.

16.3.1.5.2.2 A system of nozzles shall be provided so that each sample, in turn, is sprayed with water as the cylinder revolves.

16.3.1.5.2.3 During each 20-minute operating cycle, each sample shall be exposed to the light and water spray for 3 minutes and to the light only for 17 minutes.

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

16.3.1.6 The sample labels shall be applied to a surface material of the same type to which the label will be affixed, and this shall constitute the test sample.

16.3.1.6.1 The test sample shall be exposed for 72 hours to a temperature of 23°C ± 1°C (73°F ± 2°F) and a relative humidity of 50 ± 2 percent.

16.3.1.6.2 The test sample shall then be exposed for 240 hours in a salt spray test as specified by ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus.*

16.3.1.7 The sample labels shall be applied to a surface material of the same type to which the label will be affixed, and this shall constitute the test sample.

16.3.1.7.1 The test sample shall be exposed for 72 hours to a temperature of 23°C ± 1°C (73°F ± 2°F) and a relative humidity of 50 ± 2 percent.

16.3.1.7.2 The test sample shall then be exposed for 48 hours of immersion in distilled water.

16.3.1.8 The sample labels shall be applied to a surface material of the same type to which the label will be affixed, and this shall constitute the test sample.

16.3.1.8.1 The test sample shall be exposed for 72 hours to a temperature of 23°C ± 1°C (73°F ± 2°F) and a relative humidity of 50 ± 2 percent.

16.3.1.8.2 Following the exposure required in 16.3.1.8.1, the test sample shall be exposed for 10 days of aging at 180°C (356°F) in a mechanical convection air oven.

16.3.2 Legibility Test.

16.3.2.1 Test samples shall be prepared as required by and exposed to the preconditions specified in 16.3.1.1, after which the label shall be examined to determine color, readability, and clarity.

16.3.2.2 Test samples shall then be prepared as required by and exposed to each precondition as specified in 16.3.1.2 through 16.3.1.8.

16.3.2.3 After exposure to each precondition, the label shall be compared to the label that was preconditioned as specified in 16.3.1.1 to determine its compliance with 16.2.1.

16.3.3 Adhesion Test.

16.3.3.1 Two test samples shall be prepared as required by and exposed to the preconditions as specified in 16.3.1.1, after which the samples shall be tested as specified in 16.3.3.3 to determine the average adhesion.

16.3.3.2 Test samples then shall be prepared as required by and exposed to each precondition as specified in 16.3.1.2 through 16.3.1.8 and tested as specified in 16.3.3.3.

16.3.3.3 Labels shall be pulled from the surface material at an angle of 90 degrees to the surface, at a constant speed of 25.4 mm (1.0 in.) per minute.

16.3.3.3.1 The force to remove the label shall be recorded automatically on a chart, and the average force calculated in N per linear millimeter (lbf per linear inch) of label width.

16.3.3.3.2 Test results shall be obtained from two test samples to comprise an average for each precondition.

16.3.3.3.3 Test results obtained from samples specified in 16.3.3.2 shall be compared to the test results obtained from samples specified in 16.3.3.1 to determine compliance with 16.2.2.

Chapter 17 Design Requirements (NFPA 1961)

17.1 Administration

17.1.1* Scope. Chapters 17 through 20 shall define the design and construction requirements for new fire hose, the testing required to verify the design and construction, and the inspection and testing required of all new fire hose.

17.1.2* Purpose. The purpose of Chapters 17 through 20 shall be to establish the minimum requirements for new fire hose.

17.1.3 Application. Chapters 17 through 20 shall apply to new attack hose, occupant use hose, forestry hose, supply hose, and suction hose.

17.1.4 Retroactivity. Chapters 17 through 20 shall not be applied retroactively.

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

17.1.6* Units. In this standard, inch-pound units for measurement are followed by an equivalent in metric units, but only the first stated value shall be regarded as the requirement.

17.2 Requirements for Attack Hose.

17.2.1* Attack hose shall have a minimum design service test pressure of 300 psi (20.7 bar).

17.2.2 Attack hose shall withstand a test pressure of two times its design service test pressure without movement of couplings, leakage, or breaking of any thread in the reinforcement when subjected to the proof test specified in Section 19.2.

17.2.3 A test sample of the attack hose shall withstand a test pressure of three times the designed service test pressure without failure when subjected to the burst test specified in Section 19.5.

17.2.4 A full length of hose shall withstand a test pressure of 1.5 times the designed service test pressure without breaking any thread in the reinforcement when subjected to the kink test specified in Section 19.4.

17.2.5 The maximum elongation shall not exceed 8 percent for hose sizes through 2½ in. (65 mm), 10 percent for 3 in. (76 mm) hose size, and 13 percent for 3½ in. (90 mm) or larger hose size when tested as specified in Section 19.3.

17.2.6 The maximum twist in turns per 50 ft (15 m) shall not exceed 4¼ turns for hose sizes through 2 in. (51 mm), and 1¾ turns for hose sizes of 2½ in. (65 mm) or larger when tested as specified in Section 19.3, and the final twist shall be in a direction that tightens the couplings.

17.2.7 The maximum warp shall not exceed 20 in. (508 mm) when tested as specified in Section 19.3.

17.2.8 There shall be no rise permitted when tested as specified in Section 19.3.

17.3 Requirements for Supply Hose.

17.3.1 The minimum trade size for supply hose shall be 3½ in. (90 mm).

17.3.2* Supply hose shall have a minimum design service test pressure of 200 psi (13.8 bar).

17.3.3 Supply hose shall withstand a test pressure of two times its design service test pressure without movement of couplings, leakage, or breaking of any thread in the reinforcement when subjected to the proof test specified in Section 19.2.

17.3.4 A test sample of the supply hose shall withstand a test pressure of three times the designed service test pressure without failure when subjected to the burst test specified in Section 19.5.

17.3.5 A full length of supply hose shall withstand a test pressure of 1½ times the designed service test pressure without breaking any thread in the reinforcement when subjected to the kink test specified in Section 19.4.

17.3.6 The maximum elongation shall not exceed 10 percent when tested as specified in Section 19.3.

17.3.7 The maximum twist in turns per 50 ft (15 m) shall not exceed 1¾ turns when tested as specified in Section 19.3, and the final twist shall be in a direction that tightens the couplings.

17.3.8 The maximum warp shall not exceed 20 in. (508 mm) when tested as specified in Section 19.3.

17.3.9 There shall be no rise permitted when tested as specified in Section 19.3.

17.4 Requirements for Occupant Use Hose.

17.4.1* Occupant use hose shall have a minimum design service test pressure of 150 psi (10.3 bar).

17.4.2 Occupant use hose shall withstand a test pressure of two times its design service test pressure without movement of couplings, leakage, or breaking of any thread in the reinforcement when subjected to the proof test specified in Section 19.2.

17.4.3 A test sample of the occupant use hose shall withstand a test pressure of three times the designed service test pressure without failure when subjected to the burst test specified in Section 19.5.

17.4.4 A full length of occupant use hose shall withstand a test pressure of 1½ times the designed service test pressure without breaking any thread in the reinforcement when subjected to the kink test specified in Section 19.4.

17.4.5 The maximum elongation shall not exceed 10 percent when tested as specified in Section 19.3.

17.4.6 The maximum twist in turns per 50 ft (15 m) shall not exceed 7½ turns when tested as specified in Section 19.3, and the final twist shall be in a direction that tightens the couplings.

17.4.7 The maximum warp shall not exceed 20 in. (508 mm) when tested as specified in Section 19.3.

17.4.8 There shall be no rise greater than 7 in. (178 mm) permitted when tested as specified in Section 19.3.

17.5 Requirements for Forestry Hose.

17.5.1* The maximum weight of a lined, cotton-synthetic woven reinforcement forestry fire hose assembly shall be the following:

(1) 20.5 lb (9.3 kg) for 100 ft (30 m) of 1 in. (25 mm) hose
(2) 27 lb (12.3 kg) for 100 ft (30 m) of 1½ in. (38 mm) hose
(3) 10.9 lb (4.9 kg) for 50 ft (15 m) of 1 in. (25 mm) hose
(4) 14.8 lb (6.7 kg) for 50 ft (15 m) of 1½ in. (38 mm) hose

17.5.2* The maximum weight of a lined, synthetic woven reinforcement forestry fire hose assembly shall be the following:

(1) 10 lb (4.5 kg) for 100 ft (30 m) of 1 in. (25 mm) hose
(2) 16 lb (7.3 kg) for 100 ft (30 m) of 1½ in. (38 mm) hose
(3) 5 lb (2.3 kg) for 50 ft (15 m) of 1 in. (25 mm) hose
(4) 8 lb (3.6 kg) for 50 ft (15 m) of 1½ in. (38 mm) hose

17.5.3* Forestry hose shall have a minimum design service test pressure of 300 psi (20.7 bar).

17.5.4 Forestry hose shall withstand a test pressure of two times its design service test pressure without movement of couplings, leakage, or breaking of any thread in the reinforcement when subjected to the proof test specified in Section 19.2.

17.5.5 A test sample of the forestry hose shall withstand a test pressure of three times the designed service test pressure without failure when subjected to the burst test specified in Section 19.5.

17.5.6 A full length of forestry hose shall withstand a test pressure of 1½ times the designed service test pressure without

breaking any thread in the reinforcement when subjected to the kink test specified in Section 19.4.

17.5.7 The maximum elongation shall not exceed 10 percent when tested as specified in Section 19.3.

17.5.8 The maximum twist in turns per 50 ft (15 m) shall not exceed 12 turns for 1 in. (25 mm) hose and 8 turns for 1½ in. (38 mm) hose when tested as specified in Section 19.3, and the final twist shall be in a direction that tightens the couplings.

17.5.9 The maximum warp shall not exceed 25 in. (635 mm) when tested as specified in Section 19.3.

17.5.10 There shall be no rise greater than 8 in. (203 mm) permitted when tested as specified in Section 19.3.

17.5.11 Flexibility and Compressibility.

17.5.11.1 For cotton-synthetic woven reinforcement fire hose, the load required to compress the hose shall not exceed 100 lb (45.4 kg) for 1 in. (25 mm) hose and 125 lb (56.75 kg) for 1½ in. (38 mm) hose when two samples are tested for flexibility and compressibility in accordance with Section 19.13.

17.5.11.2 For synthetic woven reinforcement fire hose, the load required to compress the hose shall not exceed 40 lb (18.1 kg) for 1 in. (25 mm) hose and 55 lb (24.9 kg) for 1½ in. (38 mm) hose when two samples are tested for flexibility and compressibility in accordance with Section 19.13.

17.6 Requirements for Suction Hose. The requirements of Chapters 18, 19, and 20 shall not apply to suction hose except as specified herein.

17.6.1 The internal diameter of the suction hose shall comply with Section 18.1.

17.6.2 The internal surface of the suction hose shall be smooth and free of corrugations.

17.6.3 If a lining is provided, it shall meet the requirements of 18.4.5.1.

17.6.4 If a cover is provided, it shall meet the requirements given in 18.4.6.

17.6.5 The suction hose shall be constructed to withstand an internal vacuum of at least 23 in. Hg (0.78 bar) without failure, including the collapse of the liner or the cuffed (soft) ends, when applicable in the coupling bowl area.

17.6.6 The hose shall be designed for use in ambient conditions ranging from –30°F to 140°F (–34°C to 60°C).

17.6.7 The tensile strength of any elastomeric material shall not decrease by more than 20 percent of the original value, and the elongation shall not decrease by more than 50 percent of the original value when tested in accordance with Section 19.8.

17.6.7.1 The tensile strength and ultimate elongation shall meet the requirements of 18.4.7.1 and 18.4.7.2.

17.6.8 The material used for the tube and the cover, if provided, shall pass the Low-Temperature Test on Tube and Cover of ASTM D380, *Standard Test Methods for Rubber Hose*, when subjected to the cold chamber for 5 hours at –30°F (–34°C).

17.6.9 All elastomeric material shall show no visible signs of cracking when subjected to the ozone test specified in Section 19.9.

17.6.10 If the suction hose is designed for use under vacuum only, the hose assembly shall be indelibly marked in letters no less than 3/16 in. (4.8 mm) high with the words "for vacuum use only."

17.6.11 After the hose has been coupled, it shall be subjected to a vacuum of 23 in. Hg (0.78 bar).

17.6.11.1 Once the vacuum has been established, the hose shall maintain that vacuum for 10 minutes with no loss of vacuum.

17.6.11.2 The vacuum pump shall not be used to maintain the vacuum during the 10-minute period.

17.6.11.3 After the test has been completed, the hose and any component shall be visually inspected for any sign of collapse or failure.

17.6.12 Suction hose shall comply with the requirements of Sections 20.1 and 20.2.

17.7 Booster Hose.

17.7.1 Booster hose shall comply with the requirements of ANSI/UL 92, *Fire Extinguisher and Booster Hose*, or meet the requirements provided in this standard for attack hose.

17.7.1.1 Booster hose shall not be required to pass the abrasion test for attack hose provided in 18.5.1.1.

17.7.1.2 This requirement shall not apply to booster hose at service pressure above 500 psi (34.5 bar).

Chapter 18 Construction Requirements (NFPA 1961)

18.1 Diameter.

18.1.1* The hose shall have an internal diameter (ID) of not less than the trade size of the hose.

18.1.2 Hose with a trade size of 1, 1½, 1¾, 2, 2¼, 2½, or 2¾ in. (25, 32, 44, 51, 57, 64, and 70 mm) shall have an ID no greater than 3/16 in. (4.76 mm) for the trade size as measured in UL 19, *Lined Fire Hose and Hose Assemblies*.

18.1.3 Hose with a trade size of 3, 3½, 4, 4½, 5, or 6 in. (76, 89, 102, 114, 127, and 152 mm) shall have an ID of not less than the trade size of the hose and not greater than ½ in. (12.7 mm) the trade size, as measured in UL 19, *Lined Fire Hose and Hose Assemblies*.

18.1.4* The ID of a hose shall be measured in accordance with Section 5 of UL 19, *Lined Fire Hose and Hose Assemblies*.

18.1.5* The charged ID at 50 psi and 150 psi shall be publicly published by the hose manufactures for hose sizes less than 3 in. (76 mm).

18.1.6* The charged outside diameter (OD) at 150 psi shall be publicly published by the hose manufactures for hose sizes less than 3 in. (76 mm).

18.2 Length.

18.2.1 The length of the hose shall be between –2 percent and +4 percent of the nominal stated length of the hose.

18.2.1.1 The length of hose from which the burst sample has been taken shall be permitted to be 3 ft (0.9 m) shorter than the required length as stated in 18.2.1.

18.2.2 Each length shall be measured as specified in 19.2.6.

18.3 Reinforcement.

18.3.1* Hose reinforcement shall be made from one of the following materials, and the material shall be approved:

(1) Natural fiber
(2) Synthetic fiber
(3) Combination of natural and synthetic fiber

18.3.2 Reinforcements shall be evenly and firmly woven and as free from defects, dirt, knots, lumps, and irregularities that might affect the serviceability of the hose as is consistent with good manufacturing practice.

18.3.3 If the hose has a woven reinforcement, all knots shall be tucked under the warp threads.

18.3.4* If the hose has a fabric reinforcement, each layer of reinforcement shall be seamless and have the filling woven around the hose throughout its length and the warps interwoven with and substantially covering the filling.

18.3.5 The hose shall be designed and manufactured such that, in the event of a burst, the weft threads fail first.

18.3.6 When mildew treatment for the reinforcement is provided, the hose manufacturer shall certify that the mildew treatment meets the requirements of USDA Specification 5100-186d, *Forest Service Specification for Fire Hose, Cotton-Synthetic, Lined, Woven Jacket, 1 inch and 1 1/2 inch*, and USDA Specification 5100-187c, *Forest Service Specification for Fire Hose, Lightweight Synthetic, Lined, Woven Jacket.*

18.4 Linings and Covers.

18.4.1* All fire hose shall be lined.

18.4.2 Liners and covers, if provided, shall be made from one of the following materials, and the material shall be approved:

(1) Rubber compound
(2) Thermoplastic material
(3) Blends of rubber compounds and thermoplastic material
(4) Natural rubber-latex-coated fabric

18.4.3 The lining shall be of uniform thickness.

18.4.4 The waterway surface of the lining shall be free from pitting, irregularities, or other imperfections that might affect the serviceability of the hose.

18.4.5 Lining Adhesion.

18.4.5.1 The adhesion between the lining and the reinforcement shall be such that the rate of separation of a 1½ in. (38 mm) strip of the lining from the reinforcement not be greater than 1 in. (25 mm) per minute with a weight of 12 lb (5.4 kg) when tested in accordance with 19.6.1 through 19.6.6.

18.4.5.2 If a rubber backing is used between the lining and the reinforcement, the adhesion between the lining and the backing and between the backing and the reinforcement shall be such that the rate of separation of a 1½ in. (38 mm) strip not be greater than 1 in. (25 mm) per minute with a weight of 12 lb (5.4 kg), as specified in 19.6.7 and 19.6.8.

18.4.5.3 The requirement of 18.4.5.1 shall not exclude a construction that provides no adhesion between the reinforcement and lining along the fold if the surface where there is no adhesion is not greater than 35 percent of the total surface.

18.4.6 If the hose has a woven reinforcement and is equipped with a cover, the adhesion between the cover and the woven reinforcement shall be such that the rate of separation of a 1½ in. (38 mm) strip of the cover from the reinforcement not be greater than 1 in. (25 mm) per minute with a weight of 10 lb (4.5 kg) as specified in 19.6.1 through 19.6.6.

18.4.7 Tensile Strength and Ultimate Elongation.

18.4.7.1 The tensile strength and ultimate elongation of specimens taken from the elastomer material shall not be less than as stated in Table 18.4.7.1 when tested as specified in Section 19.7.

18.4.7.2 If the hose is equipped with oil-resistant liners or covers, the ultimate elongation shall not be less than 250 percent provided that the tensile strength and ultimate elongation do not decrease more than 50 percent when tested in accordance with Section 19.12.

18.4.7.3 The tensile strength of liners for forestry hose shall not be less than 1800 psi (12,410 kPa).

18.4.7.4 The tensile strength and ultimate elongation of specimens subjected to the oven aging test, as specified in Section 6.8, shall not be less than 75 percent of the tensile strength and ultimate elongation of specimens not subjected to this test.

18.4.8 Ozone Resistance.

18.4.8.1 For hose intended to be ozone-resistant, the elastomer components shall show no visible signs of cracking when subjected to the ozone test specified in Section 19.9.

18.4.8.2 Hose that meets the requirements of 18.4.8.1 shall be marked "ozone resistant" in letters and figures at least 1 in. (25 mm) high.

18.4.9 Cold Resistance.

18.4.9.1 All hose except suction hose shall show no apparent damage to the reinforcement or lining when subjected to the cold bending test specified in Section 19.10.

18.4.9.2 The hose shall not leak or show breakage of any thread in the reinforcement or slippage of couplings when subjected to the proof test pressure as specified in 19.10.5.

18.4.9.3 Special Cold-Resistant Hose.

18.4.9.3.1 If the hose is designed for use down to –65°F (–54°C), it shall show no apparent damage to the reinforcement or lining when subjected to the cold bending test specified in Section 19.10.

Table 18.4.7.1 Tensile Strength and Ultimate Elongation for Elastomer Materials in Fire Hose

Material	Tensile Strength		Ultimate Elongation (%)
	psi	kPa	
Natural and synthetic rubber	1,200	8,275	400
Latex rubber	1,800	12,410	700
Thermoplastic	2,000	13,790	400
PVC	1,200	8,275	400
Other	1,200	8,275	400

18.4.9.3.2 The hose shall not leak or show breakage of any thread in the reinforcement or slippage of couplings when subjected to the proof test pressure as specified in 19.10.5.

18.4.9.3.3 It shall be possible for one person to uncoil and lay out a 50 ft (15 m) length of hose immediately after it has been subjected to the cold flexibility test as specified in Section 19.11.

18.4.9.3.4 Hose that meets the requirements of 18.4.9.3.1, 18.4.9.3.2, and 18.4.9.3.3 shall be marked "for use down to –65°F (–54°C)" in letters and figures at least 1 in. (25 mm) high.

18.5 Hose Characteristics.

18.5.1 Attack Hose.

18.5.1.1 The material selected in 18.3.1 and 18.4.2 for the construction of attack hose shall be capable of being manufactured into a hose that has all of the following qualities:

(1) Abrasion resistance and ability to pass the Abrasion Test in ANSI/UL 19, *Lined Fire Hose and Hose Assemblies*, the multiple-jacketed hose requirements of Section 15.1, and the Abrasion Test defined in FM Approval 2111, *Factory Mutual Approval Standard for Fire Hose*
(2) Heat resistance and ability to pass the Heat-Resistance Test in ANSI/UL 19, *Lined Fire Hose and Hose Assemblies*, and the Heat Resistance Test in FM Approval 2111, *Factory Mutual Approval Standard for Fire Hose*
(3) Ability for 1½ in. to 3 in. (38 mm to 76 mm) attack hose to pass the Friction Loss Test in ANSI/UL 19, *Lined Fire Hose and Hose Assemblies*
(4) Resistance to degradation from moisture when soaked in water for 48 hours
(5) Ability to withstand 100,000 cycles of repeated bending [hose size of 3½ in. (90 mm) or less nominal size]
(6) Ability to withstand 2000 cycles of alternating pressures between 0 psi (0 bar) and the service test pressure of the fire hose

18.5.1.2 Attack hose sizes 1½ in. to 3 in. (38 mm to 76 mm) shall be tested in accordance with the following in ANSI/UL 19, *Lined Fire Hose and Line Assemblies*:

(1)* The Radiant Heat Test
(2)* The Conductive Heat Test

18.5.2 Supply Hose. The material selected in 18.3.1 and 18.4.2 for the construction of supply hose shall be capable of being manufactured into a hose that has all of the following qualities:

(1) Abrasion resistance and ability to pass the Abrasion Test in ANSI/UL 19, *Lined Fire Hose and Hose Assemblies*, and the Abrasion Test defined in FM Approval 2111, *Factory Mutual Approval Standard for Fire Hose*
(2) Heat resistance and ability to pass the Heat-Resistance Test in ANSI/UL 19, *Lined Fire Hose and Hose Assemblies*, and the Heat Resistance Test in FM Approval 2111, *Factory Mutual Approval Standard for Fire Hose*
(3) Resistance to degradation from moisture when soaked in water for 48 hours
(4) Ability to withstand 2000 cycles of alternating pressures between 0 psi (0 bar) and the service test pressure of the fire hose

18.5.3 Occupant Use Hose and Forestry Hose. The material selected in 18.3.1 and 18.4.2 for the construction of occupant use hose or forestry fire hose shall be capable of being manufactured into a hose that has all of the following qualities:

(1) Abrasion resistance and ability to pass the Abrasion Test in ANSI/UL 219, *Lined Fire Hose for Interior Standpipes*
(2) Heat resistance and ability to pass the Heat Resistance Test defined in ANSI/UL 219, *Lined Fire Hose for Interior Standpipes*
(3) Resistance to degradation from moisture when soaked in water for 48 hours
(4) Ability to withstand 10,000 cycles of repeated bending

18.6 Marking.

18.6.1 Each length of fire hose shall be indelibly marked in letters and figures at least 1 in. (25 mm) high with the manufacturer's identification, the country of origin, the month and the year of manufacture, and the words "service test to [the service test pressure] psi (bar) per NFPA 1962."

18.6.1.1* The service test pressure marked on the hose shall be permitted to be less than the design service test pressure but not less than the minimum designed service test pressure defined in Chapter 17.

18.6.2 These markings shall be in a minimum of two places on each length of hose greater than 25 ft (7.6 m) in length, beginning 5 ft ± 6 in. (1.5 m ± 152 mm) from the ends of the hose unless the hose is marked at continuous intervals not exceeding 12 ft (3.7 m).

18.6.2.1 Hose 25 ft (7.6 m) or less shall be marked in one place centered on the hose.

18.6.3 Single jacket hose with a service test pressure of 300 psi (20.7 bar) and above shall be marked with the words "Single Jacket."

18.6.4 Additional Marking on Large-Diameter Hose.

18.6.4.1 Each length of large-diameter supply hose meeting the requirements of Section 17.3 shall be indelibly marked lengthwise in letters at least 2 in. (51 mm) high with the words "supply hose."

18.6.4.2 Each length of large-diameter attack hose meeting the requirements of Section 17.2 shall be indelibly marked lengthwise in letters at least 2 in. (51 mm) high with the words "attack hose."

18.6.4.3 The marking shall be centered in the first 5 ft ± 6 in. (1.5 m ± 150 mm) from each end of the hose.

18.6.5 No markings referring to pressure, other than the service test pressure specified in 18.6.1, shall appear on the hose.

Chapter 19 Test Methods for Manufacturers' Hose Certification (NFPA 1961)

19.1 General.

19.1.1 The test procedures defined in this chapter shall be performed only under controlled laboratory conditions by the hose manufacturer, its designated agent, or by an approved testing facility designated by the manufacturer.

19.1.2 The tests shall not be performed by users in uncontrolled, non-laboratory situations.

19.2 Proof Test.

19.2.1 The test shall be conducted on a test table that has a clear space of at least 20 in. (508 mm) on each side of a line drawn through the center of the supply connection parallel to the edges of the test table.

19.2.2 To facilitate the complete removal of air from the hose, the surface of the test table shall be inclined with the supply at the low end.

19.2.3 The hose shall be filled with water until all air has been exhausted.

19.2.4 The valve shall be closed and the pressure adjusted to 10 psi (70 kPa).

19.2.5 While at 10 psi (70 kPa), the hose shall be straightened out.

19.2.6 The length of the hose shall be measured between the inside edges of the couplings and recorded to the nearest 1 in. (25 mm).

19.2.7 The hose shall be marked behind the coupling.

19.2.8 The pressure in the hose shall be increased at a rate of not less than 300 psi (20.7 bar) or more than 1000 psi (69 bar) per minute until the required test pressure is reached.

19.2.9 Proof test pressure shall be held for at least 15 seconds and not more than 1 minute.

19.2.10 The hose shall be examined for movement of the couplings after the test.

19.3 Elongation, Twist, Warp, and Rise Tests.

19.3.1* The elongation test, twist test, warp test, and rise test shall be permitted to be run at the same time the proof test is being run.

19.3.2 If the tests are to be run at a different time than while the proof test is being run, the hose shall be set up for testing as required by 19.2.1 through 19.2.5.

19.3.3 Elongation Test.

19.3.3.1 The length of the hose shall be measured between the inside edges of the couplings and recorded to the nearest 1 in. (25 mm).

19.3.3.2 The pressure in the hose shall be raised as described in 19.2.8 from the initial pressure of 10 psi (70 kPa) to the proof test pressure.

19.3.3.3* The measurement shall be taken parallel to the edge of the test table.

19.3.3.4 All measurements shall be taken from the inside edges of the fittings.

19.3.3.5 The elongation of the hose shall be calculated as the percent change from the initial measurement taken at 10 psi (70 kPa) to the final measurement taken at the proof test pressure.

19.3.4 Twist Test.

19.3.4.1 The pressure in the hose shall be raised as described in 19.2.8 from the initial pressure of 10 psi (70 kPa) to the proof test pressure.

19.3.4.2 The amount of twist shall be measured by following a color line in the hose or by noting, in the period during which the pressure is being raised, the turns of the fitting at the free end of the hose.

19.3.4.3 The amount of twist shall be recorded to the nearest one-eighth turn or 45 degrees.

19.3.4.4 The direction of twist shall be reported as right or left, with a right twist being in the direction that would tend to tighten the couplings.

19.3.5 Warp Test.

19.3.5.1 The pressure in the hose shall be raised as described in 19.2.8 from the initial pressure of 10 psi (70 kPa) to the proof test pressure.

19.3.5.2 For hose having a nominal length of 50 ft (15 m), the amount of warping shall be the maximum deviation of any portion of the hose from a straight line running from the center of the fitting at one end to the center of the fitting at the other end of the hose.

19.3.5.3* For hose having a nominal length greater than 50 ft (15 m) and up to 100 ft (30 m), the amount of warping shall be the maximum deviation of a 50 ft (15 m) portion of the hose from a straight line starting from the center of the fitting at one end and running to a point on the center of the hose 50 ft (15 m) from that fitting.

19.3.5.4 The warp shall be measured as the distance from the referenced straight line to the center line of the hose at the point of maximum deviation.

19.3.6 Rise Test.

19.3.6.1 The pressure in the hose shall be raised as described in 19.2.8 from the initial pressure of 10 psi (70 kPa) to the proof test pressure.

19.3.6.2 The distance that the hose rises above the test table shall be measured to the nearest 1 in. (25 mm) and recorded as the rise.

19.3.7 If the first measurement of warping is excessive, the position of the hose relative to the water supply shall be permitted to be reversed, end for end, and the test for warping repeated.

19.3.8 Rise shall be measured to the nearest 1 in. (25 mm) and is the distance that the hose rises above the test table when the hose is subjected to the proof test pressure.

19.4 Kink Test.

19.4.1 The test shall be conducted on a test table that shall have a clear space of at least 20 in. (508 mm) on each side of a

line drawn through the center of the supply connection parallel to the edges of the test table.

19.4.2 To facilitate the complete removal of air from the hose, the surface of the test table shall be inclined with the supply at the low end.

19.4.3 The hose shall be filled with water until all air has been exhausted.

19.4.4 The valve shall be closed and the pressure adjusted to 10 psi (70 kPa).

19.4.5 The hose shall be sharply kinked 18 in. (457 mm) from the free end by tying the hose back against itself as close to the fittings as practicable.

19.4.6 The pressure shall be raised as described in 19.2.8 to the test pressure and immediately released.

19.5* Burst Test.

19.5.1 One 3 ft (0.9 m) sample shall be cut from the end of two lengths of hose and submitted for testing before the hose is subjected to the proof test.

19.5.2 One of the samples shall be tested while lying straight and the other while lying curved on a surface having a radius of 27 in. (685 mm).

19.5.3* The test shall be conducted within a protective enclosure.

19.5.4 The 3 ft (0.9 m) samples shall be connected to the water supply, the air expelled, and the pressure raised until the specified burst pressure is reached.

19.6 Adhesion Test.

19.6.1 The apparatus required for this test shall consist of a supporting frame, clamps, weights, weight holders, and a timer.

19.6.2 The supporting frame shall be of such design that specimens with weights attached can be suspended vertically and hang freely during the progress of the test.

19.6.3 The specimen for the adhesion test shall be cut transversely.

19.6.3.1 The specimen shall be 2 in. (51 mm) wide and shall be cut through so as to give a rectangular sample 2 in. (51 mm) wide and the full circumference of the hose in length.

19.6.3.2 A strip of lining, or cover if provided, 1½ in. (38 mm) wide shall be cut out accurately, with the cut extending through the rubber but not entirely through the woven reinforcement.

19.6.4 The lining or cover and the woven reinforcement shall be separated for about 1½ in. (38 mm), and a reference mark shall be placed on the reinforcement at the juncture of the reinforcement and the lining.

19.6.4.1 The free end of the woven reinforcement shall be gripped in a stationary clamp.

19.6.4.2 The separated rubber shall be gripped in a freely suspended clamp hanging vertically, to which the prescribed weight shall be attached.

19.6.4.3 Provision shall be made for supporting and releasing the weight slowly without jerking.

19.6.5 The distance through which separation takes place shall be noted for a period of 10 minutes or until complete separation occurs.

19.6.6 The adhesion to the reinforcement shall be taken as the rate obtained by dividing the total distance separated by inches (millimeters), to the nearest 0.1 in. (2.54 mm), by the elapsed time in minutes.

19.6.7 If a rubber backing is used between the lining and the reinforcement, the adhesion between the lining and the backing and the adhesion between the backing and the reinforcement shall be determined using the methods specified in 19.6.1 through 19.6.6.

19.6.8 If the adhesion between the lining and the backing or between the backing and the reinforcement cannot be determined because the backing has a tendency to tear during the test, the rate of separation between the separating members shall be considered the adhesion.

19.7 Tensile Strength and Elongation.

19.7.1 Tensile strength and elongation shall be determined in accordance with the test methods specified in ASTM D412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers — Tension*, Method A.

19.7.2 Three dumbbell specimens shall be die-cut to the dimensions given in 19.7.3.

19.7.3 The constricted portion of the specimen shall be 0.25 in. × 1.30 in. (6.35 mm × 33 mm) and the enlarged ends shall be 1 in. (25 mm) wide.

19.7.4 The constricted portion of each specimen shall be permitted to be buffed to remove fabric impressions or other surface irregularities.

19.7.4.1 Samples shall be buffed prior to cutting with the die.

19.7.4.2 If the nature or thickness of the lining is such that buffing cannot be accomplished without damaging the lining, unbuffed specimens shall be permitted to be used for the tensile strength and elongation tests.

19.7.5 Specimens shall be cut transversely from the sample.

19.7.6 Three measurements for thickness shall be made in the constricted portion of each specimen.

19.7.6.1 The minimum value obtained shall be used as the thickness of the specimen in calculating the tensile strength.

19.7.6.2 The average tensile strength of the three specimens shall be considered the tensile strength of the rubber lining or cover.

19.7.7 Two benchmarks 1 in. (25 mm) apart shall be stamped centrally on the constricted portion of each specimen.

19.7.8 If a dumbbell test specimen breaks outside the benchmarks, or if the result of either tensile strength or elongation based on the average of three specimens is not acceptable, another set of three specimens shall be tested, and the results from this set shall be considered final.

19.7.9 Results of tests of specimens that break in the curved portion just outside the benchmarks shall be permitted to be accepted if within the minimum requirements.

19.8 Oven Aging Test.

19.8.1 Three specimens shall be prepared as described in 19.7.2 through 19.7.6.

19.8.2 The specimens shall be conditioned in an oven for 96 hours at 158°F ± 3.6°F (70°C ± 2°C) following the procedures described in ASTM D573, *Standard Test Method for Rubber — Deterioration in an Air Oven*.

19.8.3 Two benchmarks 1 in. (25 mm) apart shall be stamped centrally on the constricted portion of each specimen after the conditioning.

19.8.4 The specimens shall then be tested in accordance with ASTM D412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers — Tension*, Method A.

19.9 Ozone Resistance.

19.9.1 Three specimens, sized 3¾ in. × 1 in. (85 mm × 25 mm), or as close to 1 in. (25 mm) wide as possible from small-diameter hose, shall be cut longitudinally from the liner and cover, if provided, of the sample and mounted in the specimen holder in a looped position in accordance with the procedures outlined in ASTM D1149, *Standard Test Methods for Rubber Deterioration — Cracking in an Ozone Controlled Environment*.

19.9.2 The ozone test chamber shall be regulated to give an ozone concentration of 100 pphm ± 10 pphm and a temperature of 104°F ± 1.8°F (40°C ± 1°C).

19.9.3 When constant test conditions have been obtained in the ozone test chamber, and after the mounted specimens have remained in an ozone-free atmosphere for 24 hours, the mounted specimens shall be placed in the test chamber and allowed to remain for 70 hours.

19.9.4 After the test exposure, the specimens shall be removed from the test chamber and examined with a 7-power magnifying glass.

19.10 Cold Bending Test.

19.10.1 A 3 ft (0.9 m) sample of the hose shall be provided with test fittings and immersed in a water bath at room temperature for 24 hours.

19.10.2 The hose shall be removed from the water bath and exposed to room atmosphere for 15 minutes.

19.10.3 The hose shall be placed in a cold box for 24 hours with the temperature maintained at –4°F ± 1.8°F (–20°C ± 1°C) unless the hose is being tested for special cold resistance, in which case the temperature shall be maintained at –65°F ± 3.6°F (–54°C ± 2°C).

19.10.4 After 24 hours in the cold box, the hose shall be removed from the box and immediately bent double on itself, 180 degrees, first one way and then the other.

19.10.5 The hose shall then be allowed to thaw at room temperature for 24 hours and then be subjected to the proof test pressure as specified in Section 19.2.

19.11 Cold Flexibility Test.

19.11.1 A 50 ft (15 m) length of dry hose shall be tightly coiled and placed in a cold box for 24 hours with the temperature maintained at –65°F ± 3.6°F (–54°C ± 2°C).

19.11.2 After 24 hours in the cold box, the hose shall be removed from the box and an attempt shall be made immediately by one operator to uncoil and lay out the hose.

19.12 Oil Immersion Test.

19.12.1 A sample of the liner shall be immersed in a petroleum-based oil at 250°F ± 1.8°F (121°C ± 1°C) for 18 hours, and the tensile strength and elongation determined as specified in Section 19.7.

19.12.2 The oil used in this test shall be a medium-swelling petroleum-based oil with a viscosity of 100 ± 5 Saybolt Universal seconds at 210°F (98.9°C), an aniline point of 199.4°F ± 5.4°F (93°C ± 3°C), and an open cup flash point of 475°F ± 10°F (246.1°C ± 5.6°C).

19.13 Flexibility and Compressibility Testing.

19.13.1 The flexibility and compressibility test apparatus shall consist of a compression tester with plates of a nominal 6 in. (152 mm) length and a nominal 4 in. (102 mm) width.

19.13.2 The compression tester shall be an accepted laboratory instrument having a rate of travel of approximately 0.25 in. (6.35 mm) per minute.

19.13.3 Two lengths of hose each 20 in. (508 mm) shall be obtained from the uncoupled hose coil, using the hose following the sample taken for the burst pressure test.

19.13.4 The 20 in. (508 mm) test sample shall be prepared with a small pinprick every 1 in. (25 mm) longitudinally and parallel to the fold on each side to allow air to escape during compression of the test sample.

19.13.4.1 The pinpricks shall be located 0.4 in. ± 0.1 in. (10 mm ± 2.5 mm) from each fold on each side of the hose.

19.13.4.2 Each pinprick shall penetrate at least 1 thickness and shall be permitted to penetrate both thicknesses of hose.

19.13.5 Each sample shall be folded in an "S" shape and flattened manually so that the overall dimension of the "S" loop is 5 in. ± 0.25 in. (127 mm ± 6.35 mm) and the hose test sample is placed between compression plates of the tester, parallel to the 6 in. (152 mm) axis, as shown in Figure 19.13.5.

19.13.6 If the hose being tested is cotton-synthetic woven reinforcement fire hose, the test sample shall be compressed until there is a distance of 1 in. (25.4 mm) between the plates and the amount of load required to achieve this compression recorded.

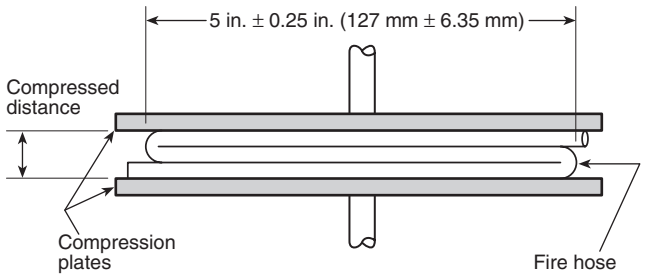


FIGURE 19.13.5 Compression and Flexibility Test Apparatus.

19.13.7 If the hose being tested is synthetic woven reinforcement fire hose, the test sample shall be compressed until there is a distance of 0.63 in. (16 mm) between the plates and the amount of load required to achieve this compression recorded.

Chapter 20 Sampling, Inspection, and Tests (NFPA 1961)

20.1 Quality Control.

20.1.1 The hose manufacturer shall have a quality control program in place that assures fire hose manufactured to this standard complies with the requirements of Chapters 17 through 20.

20.1.2 The manufacturer shall keep documentation of all design tests that show compliance with the requirements of Chapters 17 through 20.

20.1.3 Records of hydrostatic and friction loss design tests required by Chapters 17 through 20 shall be kept complete and available to the purchaser when requested at the time of purchase.

20.1.4 When requested at the time of purchase, the manufacturer shall provide the purchaser with certification that the fire hose or fire hose assembly furnished has been tested and is in compliance with the requirements of Chapters 17 through 20.

20.2 Inspection.

20.2.1 The manufacturer shall be responsible for performing all inspections required by Chapters 17 through 20. Manufacturers shall be permitted to utilize their own facilities or any approved laboratory.

20.2.2 Samples of the hose ready for delivery shall be selected in accordance with ASQ Z1.4, *Sampling Procedures and Tables for Inspection by Attributes,* for inspection of visual and dimensional characteristics.

20.3 Testing.

20.3.1 All hose shall be tested to its proof pressure in accordance with Section 19.2 after it has been coupled for delivery and shall show no signs of coupling slippage.

20.3.2 All hose shall be subjected to elongation, twist, warp, and rise tests performed in accordance with Section 19.3.

20.3.3 Samples shall be selected in accordance with ASQ Z1.4, *Sampling Procedures and Tables for Inspection by Attributes,* and tested for kink, burst, adhesion, and tensile strength and elongation.

20.3.4 Design Verification. The design of fire hose manufactured with reinforcement from fibers specified in 18.3.1 or linings and covers manufactured with materials specified in 18.4.2 shall be verified as specified in 20.3.4.1 through 20.3.4.5.

20.3.4.1 Abrasion Resistance.

20.3.4.1.1 The abrasion resistance of attack hose and supply hose shall be verified using the test procedures defined in ANSI/UL 19, *Lined Fire Hose and Hose Assemblies*, Abrasion Test; FM Approval 2111, *Factory Mutual Approval Standard for Fire Hose*, Abrasion Test; or equivalent.

20.3.4.1.2 The abrasion resistance of occupant use hose and forestry fire hose shall be verified using the test procedures defined in ANSI/UL 219, *Lined Fire Hose for Interior Standpipes*, Abrasion Test, or equivalent.

20.3.4.2 Heat Resistance.

20.3.4.2.1 The ability of attack hose and supply hose to resist heat shall be verified using the test procedures defined in ANSI/UL 19, *Lined Fire Hose and Hose Assemblies*, Heat-Resistance Test; FM Approval 2111, *Factory Mutual Approval Standard for Fire Hose*, Heat Resistance Test; or equivalent.

20.3.4.2.2 The ability of occupant use hose and forestry fire hose to resist heat shall be verified using the test procedures defined in ANSI/UL 219, *Lined Fire Hose for Interior Standpipes*, Heat-Resistance Test, or equivalent.

20.3.4.2.3 Attack hose sizes 1½ in. to 3 in. (38 mm to 76 mm) shall be tested using the test procedures defined in ANSI/UL 19, *Lined Fire Hose and Hose Assemblies,* Radiant Heat Test.

20.3.4.2.3.1 The test results shall be reported by the hose manufacturers to hose purchasers upon request.

20.3.4.2.4 Attack hose sizes 1½ in. to 3 in. (38 mm to 76 mm) shall be tested using the test procedures defined in ANSI/UL 19, *Lined Fire Hose and Hose Assemblies,* Conductive Heat Test.

20.3.4.2.4.1 The test results shall be reported by the hose manufacturers to hose purchasers upon request.

20.3.4.3 Repeated Bending.

20.3.4.3.1 The ability of attack hose 3½ in. (90 mm) or less nominal size to sustain repeated bending shall be verified using the test procedures defined in ANSI/UL 19, *Lined Fire Hose and Hose Assemblies*, Repeated Bending Test, or equivalent.

20.3.4.3.2 The ability of occupant use hose and forestry fire hose to sustain repeated bending shall be verified using the test procedures defined in ANSI/UL 219, *Lined Fire Hose for Interior Standpipes*, Repeated Bending Test, or equivalent.

20.3.4.4 Alternating Pressure. The ability of attack hose and supply hose to withstand alternating pressures shall be verified using the test procedures defined in ANSI/UL 19, *Lined Fire Hose and Hose Assemblies*, Alternating Pressure Test, or equivalent.

20.3.4.5 Moisture Resistance.

20.3.4.5.1 The ability of attack hose and supply hose to resist moisture shall be verified using the test procedures defined in ANSI/UL 19, *Lined Fire Hose and Hose Assemblies*, Wet Hose Test, or equivalent.

20.3.4.5.2 The ability of occupant use hose and forestry fire hose to resist moisture shall be verified using the test procedures defined in ANSI/UL 219, *Lined Fire Hose for Interior Standpipes*, Wet Hose Test, or equivalent.

20.3.4.6 Friction Loss. The friction loss of attack hose diameters 1½ in. to 3 in. (38 mm to 76 mm) shall be verified using the test procedures defined in ANSI/UL 19, *Lined Fire Hose and Hose Assemblies, Friction Loss Test*, or equivalent.

Chapter 21 Certification of Rescue Tools and Components (NFPA 1936)

21.1 Administration

21.1.1 Scope.

21.1.1.1 Chapters 21 through 23 shall specify the minimum requirements for the design, performance, testing, and certification of rescue tools and components thereof.

21.1.1.2 Chapters 21 through 23 shall specify the requirements for spreader, ram, cutter, combination powered rescue tools, and lifting bags.

21.1.1.3 Chapters 21 through 23 shall also specify the requirements for cable assemblies, hose assemblies, power unit components for powered rescue tools, and lifting bags.

21.1.1.4 Chapters 21 through 23 shall not specify any requirements for any accessories for powered rescue tools.

21.1.1.5 Safety and Health.

21.1.1.5.1 This standard shall not be construed as addressing all of the safety concerns, if any, associated with its use.

21.1.1.5.2 It shall be the responsibility of the persons and organizations that use this standard to establish safety and health practices and determine the applicability of regulatory limitations prior to use of this standard.

21.1.1.6 Nothing herein shall restrict any jurisdiction from specifying powered rescue tools or lifting bags and components thereof that exceed the minimum requirements of Chapters 21 through 23.

21.1.1.7 Nothing herein shall restrict any manufacturer from producing powered rescue tools, lifting bags, and components thereof that exceed the minimum requirements of Chapters 21 through 23.

21.1.2 Purpose.

21.1.2.1 The purpose of Chapters 21 through 23 shall be to establish minimum performance requirements for powered rescue tools, lifting bags, and components thereof that are used by emergency services personnel to extricate victims from entrapment.

21.1.2.2 Controlled laboratory, environmental, and physical tests are used to determine compliance with the performance requirements of Chapters 21 through 23 only; however, such tests shall not be deemed as establishing the performance levels of powered rescue tools, lifting bags, and components thereof for all situations.

21.1.2.3 Chapters 21 through 23 are not intended to serve as a detailed manufacturing or purchase specification but shall be permitted to be referenced in purchase specifications as minimum acceptable requirements.

21.1.3 Application.

21.1.3.1 Chapters 21 through 23 shall apply to the design, manufacturing, and certification of manufactured powered rescue tools, lifting bags, and components thereof.

21.1.3.2 The requirements of Chapters 21 through 23 shall not apply to accessories that might be attached to powered rescue tools, lifting bags, or components thereof.

21.1.3.3 Chapters 21 through 23 shall not apply to manually powered rescue tools and manually powered rescue tool components.

21.1.3.4 Chapters 21 through 23 shall not apply to small multipurpose tools including, but not limited to, saws, drills, chisels, pry bars, and similar tools.

21.1.3.5 Chapters 21 through 23 shall not apply to powered rescue tools and components thereof that are manufactured prior to the NFPA effective date of this standard.

21.1.3.6 Chapters 21 through 23 shall not apply to powered rescue tools that are manufactured in accordance with other specifications or standards of other organizations.

21.1.4 Units.

21.1.4.1 Values for measurement in this standard are followed by an equivalent in parentheses, but only the first stated value shall be regarded as the requirement.

21.1.4.2 Equivalent values in parentheses shall not be considered as the requirement as these values are approximate.

21.2 General.

21.2.1 The process of product certification being compliant with NFPA 1960 shall meet the requirements of Sections 21.2 through 21.5.

21.2.2 Compliance.

21.2.2.1 All products that are labeled as being compliant with Chapters 21 through 23 shall meet or exceed all applicable requirements specified in this standard.

21.2.2.2 All products that are labeled as being compliant with Chapters 21 through 23 shall be certified by a third-party certification organization.

21.2.3 Certification and Accreditation.

21.2.3.1 All certifications shall be performed by a third-party certification organization that meets at least the requirements specified in Section 21.3, and that is accredited for powered rescue tools or lifting bags, as applicable, in accordance with ISO/IEC 17065, *Conformity assessment — Requirements for bodies certifying products, processes and services.*

21.2.3.2 The accreditation shall be issued by an accreditation body operating in accordance with ISO/IEC 17011, *General requirements for accreditation bodies accrediting conformity assessment bodies.*

21.2.4 Manufacturers shall not claim compliance with portions or segments of the requirements of Chapters 21 through 23 and shall not use the NFPA name or the name or identification of this standard, NFPA 1960, in any statements about their respective product(s) unless the product(s) is certified by a third-party certification organization as compliant to this standard.

21.2.5 All compliant products shall be labeled and listed by a third-party certification organization.

21.2.6 All compliant products shall also have a product label that meets the requirements specified in Sections 22.2 and 23.2.

21.2.7* The third-party certification organization's label, symbol, or identifying mark shall be part of the product label,

attached to the product label, or immediately adjacent to the product label.

21.2.8 The third-party certification organization shall not issue any new verifications to the 2020 edition of NFPA 1936 on or after the NFPA effective date for this standard.

21.2.9 The third-party certification organization shall not permit any manufacturer to continue to label any products that are certified as compliant with the 2020 edition of NFPA 1936 on or after July 1, 2024.

21.2.10 Certification Label Removal.

21.2.10.1 The third-party certification organization shall require manufacturers to remove all certification labels and product labels indicating compliance with the 2020 edition of NFPA 1936 from all powered rescue tools and components that are under the control of the manufacturer on July 1, 2024.

21.2.10.2 The third-party certification organization shall verify the action in 21.2.10.1 is taken.

21.3 Certification Program.

21.3.1* The third-party certification organization shall not be owned or controlled by manufacturers or vendors of the product being certified.

21.3.2 The third-party certification organization shall be primarily engaged in certification work and shall not have a monetary interest in the product's ultimate profitability.

21.3.3 The third-party certification organization shall be accredited for powered rescue tools or lifting bags, as applicable, in accordance with ISO/IEC 17065, *Conformity assessment — Requirements for bodies certifying products, processes and services*, with the accreditation issued by an accreditation body operating in accordance with ISO/IEC 17011, *General requirements for accreditation bodies accrediting conformity assessment bodies*.

21.3.4 The third-party certification organization shall refuse to certify products to this standard that do not comply with all applicable requirements of this standard.

21.3.5* The contractual provisions between the third-party certification organization and the manufacturer shall specify that product certification is contingent on compliance with all applicable requirements of this standard.

21.3.5.1 The third-party certification organization shall not offer or confer any conditional, temporary, or partial product conformance verifications.

21.3.5.2 Manufacturers shall not be authorized to use any label of or reference to the third-party certification organization on products that are not compliant with all applicable requirements of this standard.

21.3.6* The third-party certification organization shall have laboratory facilities and equipment available for conducting proper tests to determine product compliance.

21.3.6.1 The third-party certification organization laboratory facilities shall have a program in place and functioning for calibration of all instruments, and procedures shall be in use to ensure proper control of all testing.

21.3.6.2 The third-party certification organization laboratory facilities shall follow good practice regarding the use of laboratory manuals, form data sheets, documented calibration and calibration routines, performance verification, proficiency testing, and staff qualification and training programs.

21.3.7 The third-party certification organization shall require the manufacturer to establish and maintain a quality assurance program that meets the requirements of Section 21.5.

21.3.8 The third-party certification organization shall verify the manufacturer's quality assurance program to ensure that the quality assurance program provides continued product compliance with Chapters 21 through 23.

21.3.9 The third-party certification organization and the manufacturer shall evaluate any changes affecting the design, construction, or materials of the compliant product to determine its continued conformance Chapters 21 through 23.

21.3.10* The third-party certification organization shall have a follow-up inspection program of the manufacturing facilities of the compliant product with at least two random and unannounced visits per 12-month period.

21.3.10.1 As part of the follow-up inspection program, the third-party certification organization shall select sample compliant product at random from the manufacturer's production line, from the manufacturer's in-house stock, or from the open market.

21.3.10.2 Sample product shall be evaluated by the third-party certification organization to verify the product's continued compliance.

21.3.11 The third-party certification organization shall have in place a series of procedures that address report(s) of situation(s) in which a compliant product is subsequently found to be hazardous.

21.3.12 The third-party certification organization's operating procedures shall provide a mechanism for the manufacturer to appeal decisions.

21.3.13 The third-party certification organization's operating procedures shall include the presentation of information from both sides of a controversy to a designated appeals panel.

21.3.14 The third-party certification organization shall be in a position to use legal means to protect the integrity of its name and label.

21.3.15 The third-party certification organization's name and label shall be registered and legally defended.

21.4 Inspection and Testing.

21.4.1 For certification of product, the third-party certification organization shall conduct both inspection and testing as specified in Section 21.4.

21.4.2 All inspections, evaluations, conditioning, and testing for product conformance verification shall be conducted by a third-party certification organization's testing laboratory that is accredited in accordance with the requirements of ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*.

21.4.2.1 The third-party certification organization's testing laboratory's scope of accreditation to ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*, shall encompass testing of powered rescue tools or lifting bags, as applicable.

21.4.2.2 The accreditation of a third-party certification organization's testing laboratory shall be issued by an accreditation body operating in accordance with ISO/IEC 17011, *General requirements for accreditation bodies accrediting conformity assessment bodies*.

21.4.3 Sampling levels for testing and inspection shall be established by the third-party certification organization and the manufacturer to ensure that products certified to this standard are compliant, unless such sampling levels are specified herein.

21.4.4 Inspection by the third-party certification organization shall include a review of all product labels to ensure that all required label attachments, compliance statements, certification statements, and other product information are at least as specified for the products in Sections 22.2 and 23.2.

21.4.5 Inspection by the third-party certification organization shall include an evaluation of any symbols and pictorial graphic representations used on product labels or in user information, as permitted by 22.2.1.6 and 22.3.3, to ensure that the symbols are explained in the product's user information package.

21.4.6 Inspection by the third-party certification organization shall include a review of the user information required by Sections 22.3 and 23.3 to ensure that the information has been developed and is available.

21.4.7 Inspection by the third-party certification organization for determining compliance with the design requirements specified in Sections 22.4 and 23.4 shall be performed on whole or complete products.

21.4.8 Testing to determine product compliance with the performance requirements specified in Sections 22.5 and 23.5 shall be conducted by the third-party certification organization in accordance with the specified testing requirements of Sections 22.6 and 23.6.

21.4.8.1 Testing shall be performed on whole products.

21.4.8.2 The third-party certification organization shall also be permitted to use specimens representative of materials and components used in the actual construction of the product.

21.4.9 The third-party certification organization shall accept from the manufacturer, for evaluation and testing for certification, only products or product components that are the same in every respect to the actual final product or product component.

21.4.10 The third-party certification organization shall not allow any modifications, pretreatment, conditioning, or other such special processes of the product or any product component prior to the submission of the product or product component for evaluation and testing by the third-party certification organization.

21.4.11 The third-party certification organization shall not allow the substitution, repair, or modification, other than as specifically permitted herein, of any product or any product component during testing.

21.4.12 The third-party certification organization shall not allow test specimens that have been conditioned and tested for one method to be reconditioned and tested for another test method unless specifically permitted in the second test method.

21.4.13 Product Changes.

21.4.13.1 Any change in the design, construction, or materials of a compliant product shall necessitate new inspection and testing to verify conformance to all applicable requirements of this standard that the third-party certification organization determines can be affected by such change.

21.4.13.2 The certification stated in 21.4.13.1 shall be conducted before labeling the modified product as being compliant with this standard.

21.5 Manufacturer's Quality Assurance Program.

21.5.1* The manufacturer shall be registered to ISO 9001, *Quality management systems — Requirements*.

21.5.2 The operation of the quality assurance program shall evaluate and test compliant product production against this standard to ensure production remains in compliance.

Chapter 22 Powered Rescue Tools (NFPA 1936)

22.1 Administration.

22.1.1 Scope.

22.1.1.1 This chapter shall specify the minimum requirements for the design, performance, testing, and certification of powered rescue tools and components thereof.

22.1.1.2 This chapter shall specify the requirements for spreader, ram, cutter, and combination powered rescue tools.

22.1.1.3 This chapter shall also specify the requirements for cable assemblies, hose assemblies, and power unit components for powered rescue tools.

22.1.1.4 This chapter shall not specify any requirements for any accessories for powered rescue tools or components thereof.

22.1.1.5 Safety and Health.

22.1.1.5.1 This chapter shall not be construed as addressing all of the safety concerns, if any, associated with its use.

22.1.1.5.2 It shall be the responsibility of the persons and organizations that use this standard to establish safety and health practices and determine the applicability of regulatory limitations prior to use of this standard.

22.1.1.6 Nothing herein shall restrict any jurisdiction from specifying powered rescue tool systems and components thereof that exceed the applicable minimum requirements of this standard.

22.1.1.7 Nothing herein shall restrict any manufacturer from producing powered rescue tools and components thereof that exceed the applicable minimum requirements of this standard.

22.1.2 Purpose.

22.1.2.1 The purpose of this chapter shall be to establish minimum performance requirements for powered rescue tools and components thereof that are utilized by emergency services personnel to facilitate the extrication of victims from entrapment.

22.1.2.2 Controlled laboratory, environmental, and physical tests are used to determine compliance with the performance

requirements of this chapter only; however, such tests shall not be deemed as establishing the performance levels of powered rescue tools and components thereof for all situations.

22.1.2.3 This chapter is not intended to serve as a detailed manufacturing or purchase specification but shall be permitted to be referenced in purchase specifications as minimum acceptable requirements.

22.1.3 Application.

22.1.3.1 This chapter shall apply to the design, manufacturing, and certification of manufactured powered rescue tools and components thereof.

22.1.3.2 The requirements of this chapter shall not apply to accessories that might be attached to powered rescue tools or components thereof.

22.1.3.3 This chapter shall not apply to manually powered rescue tools and manually powered rescue tool components.

22.2 Product Labeling Requirements.

22.2.1 General.

22.2.1.1 All product labels for powered rescue tools and for power unit components shall also meet the requirements specified in 22.2.2.

22.2.1.2 All product labels for cable assembly components and hose assembly components shall also meet the requirements specified in 22.2.3.

22.2.1.3 On all product labels, the font size for the third-party certification organization's label, symbol, or identifying mark and the compliance statement shall be at least 2 mm ($^{3}/_{32}$ in.) high.

22.2.1.4 On all product labels, the font size for the itemized information list that follows the compliance statement, including any symbols, shall be at least 2 mm ($^{3}/_{32}$ in.) high.

22.2.1.5 All product labels shall have the text printed at least in English.

22.2.1.6 All product labels shall be permitted to use symbols and other pictorial graphic representations to supplement worded statements on the product labels where those symbols and pictorial graphic representations are explained in the user information.

22.2.1.7 All product labels shall meet the requirements of UL 969, *Standard for Marking and Labeling Systems*, for resistance to damage from temperatures between −29°C and 71°C (−20°F and 160°F) outdoor use, and exposure to oil, fuel, water, and the hydraulic fluids used in the rescue tools.

22.2.1.8 Flag labels, flag tags, and wrap-around labels shall meet the requirements of UL 969A, *Standard for Marking and Labeling Systems — Flag Labels, Flag Tags, Wrap-Around Labels, and Related Products*.

22.2.1.9 In addition to 22.2.1.7 and 22.2.1.8, where any required product labels are self-adhesive, the adhesion shall be applicable for the adhered surface.

22.2.1.10 The powered rescue tool manufacturer shall provide the country of manufacture in either the manual or on the product label.

22.2.2 Powered Rescue Tools and Power Unit.

22.2.2.1 Each powered rescue tool and each power unit shall have a product label permanently attached to the tool or system.

22.2.2.2 Each product label shall have the third-party certification organization's label, symbol, or identifying mark and at least the following compliance statement printed on the product label:

THIS (insert "POWERED RESCUE TOOL" or "POWER UNIT" as applicable) MEETS THE APPLICABLE REQUIREMENTS OF NFPA 1960, 2024 EDITION. DO NOT REMOVE THIS LABEL.

22.2.2.3 The following information shall also be printed on the product label following the compliance statement specified in 22.2.2.2:

(1) Manufacturer's name, identification, or designation
(2) Product identification number, lot number, or serial number
(3) Month and year of manufacture (not coded)
(4) Model name, number, or design
(5) Rated system pressure, where applicable
(6) Manufacturer's specified hydraulic fluid for power unit, where applicable
(7) Fluid capacity of the hydraulic reservoir of the power unit, where applicable
(8) Operating voltage and current type, where applicable
(9) Operating amperage at no load, where applicable
(10) Operating amperage at maximum load, where applicable

22.2.2.4 More than one label piece shall be permitted to carry all statements and information required of the product label; however, all label pieces that compose the entire product label shall be located adjacent to each other.

22.2.3 Cable Assembly and Hose Assembly.

22.2.3.1 Each cable assembly and each hose assembly shall have a product label that is permanently stamped, bonded, or embossed on the cable or hose.

22.2.3.2 Each product label specified in 22.2.3.1 shall have the third-party certification organization's label, symbol, or identifying mark and at least the following compliance statement printed as the product label:

MEETS NFPA 1960 (2024 ED.).

22.2.3.3 In addition, each cable assembly and each hose assembly shall also have a product label attached to it.

22.2.3.3.1 This additional product label shall be permitted to be permanently attached to the assembly or configured as a hangtag attached to the assembly.

22.2.3.3.2 Where the additional product label is configured as a hangtag as permitted by 22.2.3.3.1, the hangtag shall have the following printed on the label: DO NOT DISPOSE OF THIS HANGTAG.

22.2.3.3.3 Where the additional product label is permanently attached, the following shall be printed on the label:

DO NOT REMOVE THIS LABEL.

22.2.3.4 The third-party certification organization's label, symbol, or identifying mark and at least the following statement shall be printed on the additional product label:

THIS (insert "CABLE ASSEMBLY" OR "HOSE ASSEMBLY" as applicable) MEETS THE REQUIREMENTS OF NFPA 1960, 2024 ED.

22.2.3.5 The following information shall also be printed on the additional product label following the compliance statement specified in 22.2.3.4:

(1) Manufacturer's name, identification, or designation
(2) Product identification number, lot number, or serial number
(3) Month and year of manufacture (not coded)
(4) Model name, number, or design
(5) Rated system pressure, where applicable
(6) Manufacturer's specified hydraulic fluid for power unit, where applicable
(7) Fluid capacity of the hydraulic reservoir of the power unit, where applicable
(8) Operating voltage and current type, where applicable
(9) Operating amperage at no load, where applicable
(10) Operating amperage at maximum load, where applicable

22.2.3.6 More than one label piece shall be permitted to carry all statements and information required of the additional product label; however, all label pieces of the entire additional product label shall be attached to each other.

22.3 User Information.

22.3.1 The powered rescue tool manufacturer shall provide user information for users with each rescue tool and component thereof.

22.3.2 Such user information shall be permitted to be in the form of printed, audiovisual, or web-based material, or any combination thereof.

22.3.3 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product labels where those symbols and pictorial graphic representations are explained in the user information.

22.3.4 Manuals.

22.3.4.1 The powered rescue tool manufacturer shall provide a manual(s) with each rescue tool or component thereof.

22.3.4.2 The manual(s) shall provide, at a minimum, the following information:

(1) Manufacturer's name and address
(2) Source for service and technical information
(3) How or where parts can be obtained
(4) Setup procedures
(5) Operating instructions
(6) Safety considerations
(7) Limitations of use
(8) Inspection procedures
(9) Recommended maintenance procedures
(10) Troubleshooting guide
(11) Manufacturer's warranty
(12) Special requirements or data required by this standard

22.3.5 The powered rescue tool manufacturer shall specify in the manual the length, width, and height dimensions of all powered rescue tools and components thereof to establish the minimum storage dimensions.

22.3.6 The data for the opening distance of cutters and the opening and closing travel distance for other rescue tools as established in 22.4.2.3, 22.4.3.1, 22.4.4.3, 22.4.4.5, and 22.4.5.1 shall be provided in the manual.

22.3.7 Ratings.

22.3.7.1 The data on the cutting rating of cutters as established in 22.4.4.4 and 22.4.5.3 shall be provided in the manual.

22.3.7.2 Where cutters are rated for cutting high-strength materials, the data on the rating of cutters as established in 22.4.5.5.2 shall be provided in the manual.

22.3.8 The data on highest spreading force (HSF), lowest spreading force (LSF), highest pulling force (HPF), and lowest pulling force (LPF) ratings of the rescue tools as established in 22.5.1.4, 22.5.1.5, 22.5.2.5, 22.5.2.6, 22.5.3.6, and 22.5.3.7 shall be provided in the manual.

22.3.9 The weight of the rescue tool or component thereof in a ready-to-use configuration shall be provided in the manual.

22.3.9.1 The weight of the power unit shall include maximum specified quantities of the hydraulic fluid, fuel, engine oil, and battery, if the power unit requires these items for normal operation.

22.3.9.2 The weight of tools shall be determined with the rescue tools attached to the cable or hose assembly, which is connected to the power source during tool operation, where the tool is at a height of at least 1 m (3.28 ft) from the ground and the cable or hose assembly connected to the tool is in contact with the ground.

22.3.9.3 The weight of hose assemblies, including hose reels where provided, shall be determined with the hose assembly filled with hydraulic fluid and configured so that they would be operational by attachment to a power source.

22.3.10 The manufacturer of the power unit shall provide copies of any owner's manuals that are provided by the manufacturer of the prime mover.

22.3.11 A safety data sheet (SDS) shall be provided for each hydraulic fluid that is supplied for use in the rescue tool and components thereof.

22.4 Design Requirements.

22.4.1 General.

22.4.1.1 Where hydraulic fluid is used, the manufacturer of seals, valves, and fittings that will come into contact with hydraulic fluid in the rescue tool shall supply the rescue tool manufacturer with written documentation that such seals, valves, and fittings are compatible with the specified hydraulic fluid for the rescue tool and that they will function at a maximum hydraulic fluid temperature of 71°C (160°F).

22.4.1.2 Handles and controls shall be located on the rescue tool to allow the rescue tool to be carried and operated by personnel wearing gloves that are certified as compliant with the glove requirements of NFPA 1971.

22.4.1.3 All handles and controls shall be located and designed so that when gripped will prevent the user's hand(s)

from being caught or crushed by powered moving parts of the tool during the tool's operation.

22.4.1.4 Rescue tools shall be equipped with a "deadman control."

22.4.1.4.1 When the operating control is in the neutral position, the rescue tool shall not operate by itself.

22.4.1.4.2 The operation of the operating control shall be indicated on the tool.

22.4.1.5 Where the rescue tool has an extension area of the activating piston rod assembly that is greater than 1.5 times the retract area of the piston rod assembly, the rescue tool shall be equipped with a built-in automatic safety relief device to prevent overpressurization.

22.4.1.6 Where hydraulic fluid is used, the hydraulic fluid specified for use with the rescue tool shall not be classified as either a flammable liquid or a combustible fluid unless classified as a Class IIIB combustible liquid in accordance with NFPA 30.

22.4.1.7 Rating.

22.4.1.7.1 Where hydraulic fluid is used, all rescue tool hydraulic fittings and quick-connect couplers shall be rated for, at a minimum, the rated system input.

22.4.1.7.2 Where hydraulic fluid is used, all rescue tool hydraulic fittings and quick-connect couplers shall have a safety factor of at least 2:1.

22.4.1.8* Check Valves for Quick-Connect Couplers.

22.4.1.8.1 Rescue tools shall be equipped with quick-connect couplers.

22.4.1.8.2 Where hydraulic fluid is used, each quick-connect coupler shall have a check valve that can withstand the specified rated system input when disconnected.

22.4.1.9 All rescue tool quick-connect couplers shall be designed to prevent accidental uncoupling during operation.

22.4.1.10 All controls that are required for the safe operation of the rescue tool shall be marked to indicate their function.

22.4.1.11 The length, width, and height dimensions of the rescue tool, as supplied by the tool manufacturer, shall be verified by the third-party certification organization.

22.4.1.12 Labels.

22.4.1.12.1 All electric components shall be labeled and listed for the intended application.

22.4.1.12.2 Where labeled and listed electric components are not available for a specific application, the electric components that are used shall be evaluated for the intended application by the third-party certification organization.

22.4.1.13 Where rescue tools utilize electric power, such rescue tools shall comply with the applicable and appropriate electrical safety requirements in Annex K of UL 60745-1, *Standard for Safety for Hand-Held Motor-Operated Electric Tools — Safety — Part 1: General Requirements.*

22.4.1.14 All rescue tool electrical connectors shall be rated to handle the electrical current realized when the system is operating at rated system input.

22.4.1.15 A switch or other control device shall be acceptable for the application, with voltage and amperage ratings not less than the corresponding values of the load that it controls.

22.4.1.16 Electrical parts of the rescue tool shall be so located or enclosed that protection against unintentional contact with noninsulated live parts shall be provided.

22.4.1.17 Strain relief shall be provided to prevent a mechanical stress on a flexible cord from being transmitted to terminals, splicing, or internal wiring.

22.4.1.18 Wiring shall be protected from sharp edges, burrs, moving parts, and other conditions that might cause abrasion of the insulation of conductors.

22.4.1.19 The electric motor of the rescue tool shall drive the maximum intended load of the tool without introducing risk of fire, electric shock, or injury to persons.

22.4.1.20 Where an enclosure as part of the rescue tool or rescue tool component is provided for a battery or battery cell, the enclosure shall be vented to permit the circulation of air for dispersion of gases that can be generated under abnormal battery or battery cell or charging conditions.

22.4.1.21 Where an enclosure as part of the rescue tool or rescue tool component is provided for a battery or battery cell, the enclosure shall be provided with means of heat transfer, such as ventilation openings or heat sinks, located so as to prevent thermal runaway of the battery or battery cell during normal charging at the maximum allowable ambient temperature as specified by the battery or battery cell manufacturer.

22.4.1.22 Where rescue tools use batteries that are the prime energy source for the rescue tool, such rescue tools shall provide an indicator or other means to visually check the battery's state of charge.

22.4.1.23 All battery or battery pack exposed live terminals shall provide a means to prevent accidental contact and arcing when not being used.

22.4.1.24 Self-contained battery-powered rescue tools shall include an on/off power switch or button to de-energize the tool so that it is inoperable by the tool control device.

22.4.1.25 Self-contained battery-powered rescue tools shall provide an indicator or other means to visually indicate whether the tool is energized.

22.4.2 Additional Requirements for Spreader Rescue Tools.

22.4.2.1 Gripping Surface.

22.4.2.1.1 The outside of the spreader arm ends or tips shall be provided with a gripping surface.

22.4.2.1.2 The gripping surface shall extend the full width of the ends or tips.

22.4.2.1.3 The gripping surface shall be at least 25 mm (1 in.) in length where measured inward from the ends or tips.

22.4.2.2 Double-acting spreaders that are designed for pulling as well as pushing shall have pulling attachment points.

22.4.2.3 The opening and closing travel distance of the spreader shall be determined at 21°C, ±3°C (70°F, ±5°F).

22.4.2.3.1 The spreader shall be opened to the fullest extent using the rated system input and no external load.

22.4.2.3.2 The distance between the tips shall be measured.

22.4.2.3.3 The spreader shall then be closed to its full closure using the rated system input and no external load.

22.4.2.3.4 The distance between the tips shall again be measured.

22.4.2.3.5 The difference in measurements shall be the travel distance.

22.4.2.3.6 The opening and closing travel distances of the spreader shall be recorded and verified with the data supplied by the manufacturer.

22.4.3 Additional Requirements for Ram Rescue Tools.

22.4.3.1 The opening and closing travel distance of the ram shall be determined at 21°C, ±3°C (70°F, ±5°F).

22.4.3.1.1 The ram shall be opened to the fullest extent using the rated system input and no external load.

22.4.3.1.2 The distance from the base to the tip of the ram shall be measured.

22.4.3.1.3 The ram shall then be closed to its full closure using the rated system input and no external load.

22.4.3.1.4 The distance from the base to the tip of the ram shall again be measured.

22.4.3.1.5 The difference in measurements shall be the travel distance.

22.4.3.1.6 The fully retracted and the fully extended lengths of the ram shall be recorded and verified with the data supplied by the manufacturer.

22.4.3.2 Rams shall be permitted to pull as well as push.

22.4.3.3 Where rams are designed to pull as well as push, they shall be provided with a pulling attachment point.

22.4.4 Additional Requirements for Combination Rescue Tools.

22.4.4.1 Gripping Surface.

22.4.4.1.1 The outer edge of the combination tool arm ends or tips shall be provided with a gripping surface.

22.4.4.1.2 The gripping surface shall extend the full width of the ends or tips.

22.4.4.1.3 The gripping surface shall be at least 25 mm (1 in.) in length where measured inward from the ends or tips.

22.4.4.2 All double-acting combination tools that are designed for pulling as well as spreading shall have pulling attachment point(s).

22.4.4.3 The opening distance of the cutter of the combination tool shall be determined at 21°C, ±3°C (70°F, ±5°F).

22.4.4.3.1 The cutter shall be opened to the fullest extent using the rated system input and no external load.

22.4.4.3.2 The opening distance of the cutter shall be measured in a straight line at the tips of the cutter, with the cutter in the fully open position.

22.4.4.3.3 The opening distance of the cutter of the combination tool shall be recorded and verified with the data supplied by the manufacturer.

22.4.4.4 The cutter of the combination tool shall be rated using an alphanumeric level rating system for the cutter's ability to cut specific material.

22.4.4.4.1 The numerical performance levels and the material categories of the rating system shall be as specified in the performance requirements of 22.5.3.4 and 22.6.13.

22.4.4.4.2 Rating Expression.

22.4.4.4.2.1* The level rating shall be expressed as A#/B#/C#/D#/E#.

22.4.4.4.2.2 The letters A, B, C, D, and E shall indicate the material category, and the performance level number for the specific material category and be inserted in place of the # sign.

22.4.4.5 The opening and closing travel distance of the spreader of the combination tool shall be determined at 21°C, ±3°C (70°F, ±5°F).

22.4.4.5.1 The spreader shall be opened to the fullest extent using the rated system input and no external load.

22.4.4.5.2 The opening shall be measured in a straight line on the outside surface of the arms at the farthest projection of the tips.

22.4.4.5.3 The spreader shall then be closed to its full closure using the rated system input and no external load.

22.4.4.5.4 The distance between the tips shall again be measured.

22.4.4.5.5 The difference in measurements shall be the travel distance.

22.4.4.5.6 The opening and closing travel distance of the combination tool spreader shall be recorded and verified with the data that are supplied by the manufacturer.

22.4.4.6 Combination tool cutters shall be permitted to be rated for cutting high-strength materials.

22.4.4.6.1 Where combination tool cutters are being rated for cutting high-strength materials, the numerical performance level and category of the rating system shall be as specified in 22.5.3.12 and 22.6.15.

22.4.4.6.2 The level rating shall be expressed as F#.

22.4.4.6.3 The letter F shall indicate the material category, and the performance level number for the specific high-strength material category shall be inserted in place of the # sign.

22.4.5 Additional Requirements for Cutter Rescue Tools.

22.4.5.1 The opening distance of the cutter shall be determined at 21°C, ±3°C (70°F, ±5°F).

22.4.5.1.1 The cutter shall be opened to the fullest extent using the rated system input and no external load.

22.4.5.1.2 The opening distance of the cutter shall be measured in a straight line at the tips of the cutter, with the cutter in the fully open position.

22.4.5.2 The opening distance of the cutter shall be recorded and verified with the data supplied by the manufacturer.

22.4.5.3 The cutter shall be rated using an alphanumeric level rating system for the cutter's ability to cut specific material.

22.4.5.3.1 The numerical performance levels and the material categories of the rating system shall be as specified in the performance requirements of 22.5.4.2 and 22.6.13.

22.4.5.3.2* The level rating shall be expressed as A#/B#/C#/D#/E#.

22.4.5.4 The letters A, B, C, D, and E shall indicate the material category, and the performance level number for the specific material category shall be inserted in place of the # sign.

22.4.5.5 Cutters shall be permitted to be rated for cutting high-strength materials.

22.4.5.5.1 Where cutters are being rated for cutting high-strength materials, the numerical performance level and category of the rating system shall be as specified in 22.5.4.6 and 22.6.15.

22.4.5.5.2 The level rating shall be expressed as F#.

22.4.5.5.3 The letter F shall indicate the material category, and the performance level number for the specific high-strength material category shall be inserted in place of the # sign.

22.4.6 Cable Assembly and Hose Assembly Components.

22.4.6.1 The manufacturer of hose and couplers for hose assembly components that will come into contact with tool or system hydraulic fluid shall supply the rescue tool manufacturer with written documentation that such hose and couplers are compatible with the specified hydraulic fluid and that they will function at a maximum hydraulic fluid temperature of 71°C (160°F).

22.4.6.2 Where hydraulic fluid is used, the hydraulic fluid that is specified for use with hose assembly components shall not be classified as either a flammable or combustible liquid unless classified as a Class IIIB combustible liquid in accordance with NFPA 30.

22.4.6.3 Hose assemblies shall have a minimum safety factor against burst of 200 percent.

22.4.6.4* All hose hydraulic fittings and quick-connect couplers shall be rated for at least the rated system input and have a minimum safety factor of 200 percent.

22.4.6.5 All hose quick-connect couplers shall be designed to prevent accidental uncoupling during operation.

22.4.6.6 Electrical cables and wires for cable assembly components shall be rated to handle the electrical current realized when the system is operating at rated system input.

22.4.6.7 All quick-connect electrical cables for cable assembly components shall be polarized.

22.4.6.8 All electrical cables and wires of cable assembly components shall be insulated to prevent short circuits.

22.4.7 Power Unit Components.

22.4.7.1 Where hydraulic fluid is used, the manufacturer of seals, valves, and fittings that will come into contact with hydraulic fluid in power unit components shall supply the rescue tool manufacturer with written documentation that such seals, valves, and fittings are compatible with the specified hydraulic fluid for the rescue tool and that they will function at a maximum hydraulic fluid temperature of 71°C (160°F).

22.4.7.2 Where hydraulic fluid is used, the hydraulic fluid that is specified for use with power unit components shall not be classified as either a flammable liquid or a combustible liquid unless classified as a Class IIIB combustible liquid in accordance with NFPA 30.

22.4.7.3 All power unit hydraulic fittings and quick-connect couplers shall be rated for at least the rated system input and have a minimum safety factor of 200 percent.

22.4.7.4 All power unit quick-connect couplers shall be designed to prevent accidental uncoupling during operation.

22.4.7.5 Handles and controls shall be located on the power unit to allow the power unit to be carried and operated by personnel wearing gloves that are certified as compliant with the glove requirements of NFPA 1971.

22.4.7.6 Each power unit with a continuously operating prime mover shall be equipped with a manually operated pressure dump valve to relieve hose line pressure to allow a tool to be removed or attached while the prime mover is operating at full speed.

22.4.7.7 All power units shall have all integral control parts labeled to ensure ease of identification by the user, including, but not limited to, the following:

(1) Start switch or control
(2) Stop switch or control
(3) Choke location and position, if applicable
(4) Throttle, if applicable
(5) Fuel or power shutoff
(6) Open and closed position of any dump valve

22.4.7.8 All labeling of the prime mover, as specified by the prime mover manufacturer, shall be included.

22.4.7.9 Where the power unit includes an internal combustion prime mover, the appropriate engine fuel and engine oil reservoirs shall be indicated by a label.

22.4.7.10 Where the power unit includes an internal combustion prime mover, the manufacturer shall provide a label on the power unit that indicates the correct proportions for the fuel/oil mixture, if applicable.

22.4.7.11 Where the power unit includes an electric prime mover, the manufacturer shall provide a label on the power unit that indicates the rated horsepower, speed (rpm), amperage, and voltage.

22.4.7.12 Where the power unit includes a pneumatic prime mover, the manufacturer shall provide a label on the power unit that indicates the proper air pressure and cubic feet per minute necessary to maintain the specified rated power unit performance.

22.4.7.13 Where the power unit includes a hydraulic prime mover, the manufacturer shall provide a label on the power

unit that indicates the hydraulic pressure and flow necessary to maintain the specified rated power unit performance.

22.4.7.14 The rescue tool manufacturer shall provide the purchaser with any maintenance tools that are not commercially available and that are necessary to perform the expected service and maintenance of the power unit.

22.4.7.15 Where hydraulic fluid is used, a hydraulic fluid reservoir shall be provided and have an unobstructed port(s) for adding hydraulic fluid to the reservoir or for draining hydraulic fluid from the reservoir.

22.4.7.16 Where hydraulic fluid is used, a label shall be provided near the hydraulic fluid fill port that indicates the type of fluid that is specified by the manufacturer for use with the system.

22.4.7.17 The power unit manufacturer shall label the usable capacity of the hydraulic fluid reservoir.

22.4.7.18 All power units that weigh in excess of 22.5 kg (49 lb), including fluid, and all power units with an internal combustion engine shall be provided with an unobstructed port at the lowest point of the hydraulic fluid reservoir to allow the reservoir to be emptied when the power unit is in the upright position.

22.4.7.19 Fluid Level.

22.4.7.19.1 Where hydraulic fluid is used, the hydraulic fluid reservoir shall be provided with a means to visually determine the fluid level.

22.4.7.19.2 Such means shall include, but not be limited to, dip stick–type indicators, sight gauges, or remote fluid level gauges.

22.4.7.20 Where hydraulic fluid is used, the power unit hydraulic pump intake shall be provided with a filter screen.

22.4.7.21 The hydraulic pump shall be equipped with a pressure relief device.

22.4.7.22 Any pressure relief automatic limiting device shall be designed to deter its adjustment by the user.

22.4.7.23 All power unit electrical connectors shall be rated to handle the electrical current realized when the system is operating at rated system input.

22.4.7.24 Where an enclosure as part of the rescue tool or rescue tool component is provided for a battery or battery cell, the enclosure shall be vented to permit the circulation of air for dispersion of gases that can be generated under abnormal battery or battery cell or charging conditions.

22.4.7.25 Where an enclosure as part of the rescue tool or rescue tool component is provided for a battery or battery cell, the enclosure shall be provided with means of heat transfer, such as ventilation openings or heat sinks, located so as to prevent thermal runaway of the battery or battery cell during normal charging at the maximum allowable ambient temperature as specified by the battery or battery cell manufacturer.

22.4.7.26 Power units that use batteries shall provide an indicator or other means to visually check the battery's state of charge.

22.4.7.27 All battery or battery pack exposed live terminals shall provide a means to prevent accidental contact and arcing when not being used.

22.4.7.28 All electric components shall be listed and labeled for their intended application.

22.4.7.28.1 Where listed and labeled electric components are not available for a specific application, the electric components that are used shall be evaluated for the intended application.

22.4.7.29 All electric prime movers that are rated at greater than 100 V ac shall provide for an electric ground.

22.4.7.30 All portable internal combustion prime movers that are equipped with an electric starter shall also be equipped with a mechanical starter as a backup.

22.4.7.31 All portable internal combustion prime movers shall be equipped with a spark-arresting muffler that meets the requirements of the US Department of Agriculture Forest Service as well as a guard to prevent accidental contact with the muffler.

22.4.7.32 All internal combustion prime mover crankcases shall be equipped with an unobstructed port to allow oil to be drained without removing the internal combustion prime mover from the power unit.

22.4.7.33 All internal combustion prime movers shall have unobstructed access to the fuel tank fill cap and, where applicable, to the oil cap.

22.4.7.34 All pneumatic prime movers shall be equipped with an automatically resetting pressure relief device to prevent overpressurizing the pneumatic system.

22.4.7.35 The length, width, and height dimensions of the power unit, as supplied by the power unit manufacturer, shall be verified by the third-party certification organization.

22.4.7.36 The weight of the ready-to-use power unit, including any necessary attachments, as supplied by the power unit manufacturer, shall be verified by the third-party certification organization, including the batteries and the maximum specified quantities of all fluids including hydraulic fluid, fuel, and engine oil, if applicable.

22.5 Performance Requirements.

22.5.1 Spreaders.

22.5.1.1 Operating Temperature Test.

22.5.1.1.1 Spreaders shall be tested for operating temperature range as specified in 22.6.1.

22.5.1.1.2 Spreaders shall operate for five operational cycles during operating temperature testing.

22.5.1.1.3 Spreaders shall perform without any defect or leak during operating temperature testing.

22.5.1.2 Spreaders shall be tested for their ability to hold spreading force as specified in 22.6.6, and not have a creep value greater than 5 mm ($^{3}/_{16}$ in.) at 9 minutes.

22.5.1.3 Where spreaders are also rated for pulling, those spreaders shall be tested for the ability to hold the pulling force as specified in 22.6.7, and not have a creep value greater than 5 mm ($^{3}/_{16}$ in.) at 9 minutes.

22.5.1.4 Spreading Force Test.

22.5.1.4.1 Spreaders shall be tested for spreading forces generated as specified in 22.6.2.

22.5.1.4.2 The spreading force at each of the 10 test points shall be at least 8900 N (2000 lbf).

22.5.1.4.3 The calculated lowest spreading force (LSF) of all 10 test points shall be designated as the LSF for that specific tool.

22.5.1.4.4 The calculated highest spreading force (HSF) of all 10 test points shall be designated as the HSF for that specific tool.

22.5.1.5 Where spreaders are also rated for pulling, those spreaders shall be tested for pulling forces generated as specified in 22.6.4, and have the pulling force at each of the 10 test points be at least 7120 N (1600 lbf).

22.5.1.5.1 The lowest recorded pulling force of all 10 test points shall be designated as the lowest pulling force (LPF) for that specific tool.

22.5.1.5.2 The highest recorded pulling force of all 10 test points shall be designated as the highest pulling force (HPF) for that specific tool.

22.5.1.6 Spreaders shall be tested for endurance as specified in 22.6.8, and not have a creep value greater than 5 mm (3⁄16 in.) at 9 minutes.

22.5.1.6.1* Where spreader variants of the same basic design have different sources of power, each variant shall be tested for endurance as specified in 22.5.1.6.

22.5.1.6.2 A self-contained battery-powered spreader shall be permitted to utilize an equivalent external power supply in place of the battery during endurance testing.

22.5.1.7 Hydrostatic and Mechanical Overload Test.

22.5.1.7.1 Spreaders shall be tested for hydrostatic and mechanical overload as specified in 22.6.9 and include the following:

(1) Spreaders shall not exhibit any functional damage.
(2) Spreaders shall generate the HSF, ±8 percent, for the tool as determined in 22.5.1.4.
(3) Spreaders shall have the deadman control automatically return to the neutral position.

22.5.1.7.2 Where spreaders are also rated for pulling, those spreaders shall also generate the HPF, ±8 percent, for the tool as determined in 22.5.1.5.

22.5.1.8 The deadman control of spreaders shall be tested for endurance as specified in 22.6.10.

22.5.1.8.1 The spreader shall generate the HSF, ±8 percent, for the tool as determined in 22.5.1.4.

22.5.1.8.2 The spreader shall not have a creep value greater than 5 mm (3⁄16 in.) at 9 minutes.

22.5.1.8.3 Where a spreader is also rated for pulling, it shall also generate the HPF, ±8 percent, for the tool as determined in 22.5.1.5.

22.5.1.9 Where spreaders are equipped with a built-in automatic safety relief device in accordance with 22.4.1.5, spreaders shall be tested for proper functioning of the tool and the built-in safety relief device as specified in 5.6.11, and for operating as specified in 22.5.1.2.

22.5.1.10 Battery Spreader Opening and Closing Time. Measured opening and closing times of the spreader shall be done as follows:

(1) Unloaded at temperature specified in 22.4.2.3
(2) Unloaded at temperatures specified in 22.6.1
(3) During cycles as defined in 22.6.8

22.5.1.11 Battery-Powered Spreader Run Time. For spreaders, report the number of cycles as defined in 22.6.8 on one fully charged battery.

22.5.2 Rams.

22.5.2.1 Operating Temperature Test.

22.5.2.1.1 Rams shall be tested for operating temperature range as specified in 22.6.1.

22.5.2.1.2 Rams shall operate for five operational cycles.

22.5.2.1.3 Rams shall perform without any defect or leak.

22.5.2.2 Rams shall be tested for ability to hold spreading force as specified in 22.6.6, and not have a creep value greater than 5 mm (3⁄16 in.) at 9 minutes.

22.5.2.3 Where rams are also rated for pulling, those rams shall be tested for ability to hold pulling force as specified in 22.6.7, and not have a creep value greater than 5 mm (3⁄16 in.) at 9 minutes.

22.5.2.4 Rams shall be tested for ability to hold spreading force during reconnection of the supply hose or electrical cables as specified in 22.6.6, and not have the creep value exceed 6 mm (1⁄4 in.) before spreading begins again.

22.5.2.5 Rams shall be tested for spreading forces generated as specified in 22.6.3, and have the spreading force at each of the three test points be at least 8900 N (2000 lbf).

22.5.2.5.1 The lowest recorded spreading force of all three test points shall be designated as the LSF for that specific tool.

22.5.2.5.2 The highest recorded spreading force of all three test points shall be designated as the HSF for that specific tool.

22.5.2.6 Where rams are also rated for pulling, those rams shall be tested for pulling forces generated as specified in 22.6.5, and have the pulling force at each of the three test points be at least 7120 N (1600 lbf).

22.5.2.6.1 The lowest recorded pulling force of all three test points shall be designated as the LPF for that specific tool.

22.5.2.6.2 The highest recorded pulling force of all three test points shall be designated as the HPF for that specific tool.

22.5.2.7 Rams shall be tested for endurance as specified in 22.6.8, and not have a creep value greater than 5 mm (3⁄16 in.) at 9 minutes.

22.5.2.7.1* Where ram variants of the same basic design have different sources of power, each variant shall be tested for endurance as specified in 22.5.2.7.

22.5.2.7.2 A self-contained battery-powered ram shall be permitted to utilize an equivalent external power supply in place of the battery during endurance testing.

22.5.2.8 Hydrostatic and Mechanical Overload Test.

22.5.2.8.1 Rams shall be tested for hydrostatic and mechanical overload as specified in 22.6.9 and include the following:

(1) Rams shall not show any functional damage.
(2) Rams shall generate the HSF, ±8 percent, for the tool as determined in 22.5.2.5.
(3) Rams shall have the deadman control automatically return to the neutral position.

22.5.2.8.2 Where rams are also rated for pulling, those rams shall also generate the HPF, ±8 percent, for the tool as determined in 22.5.2.6.

22.5.2.9 The deadman control of rams shall be tested for endurance as specified in 22.6.10.

22.5.2.9.1 Rams shall not have a creep value greater than 5 mm (3⁄16 in.) at 9 minutes.

22.5.2.9.2 Where rams are also rated for pulling, those rams shall also generate the HPF, ±8 percent, for the tool as determined in 22.5.2.6.

22.5.2.10 Bending Resistance Test.

22.5.2.10.1 Rams shall be tested for bending resistance as specified in 22.6.12 and shall include the following:

(1) Rams shall not exhibit any sign of external leakage or functional damage.
(2) Rams shall generate the HSF, ±8 percent, for the tool as determined in 22.5.2.5.

22.5.2.10.2 Where rams are also rated for pulling, those rams shall also generate the HPF, ±8 percent, for the tool as determined in 22.5.2.6.

22.5.2.11 Where rams are equipped with a built-in automatic safety relief device in accordance with 22.4.1.5, rams shall be tested for correct functioning of the tool and the safety relief device as specified in 22.6.11, and for operating as specified in 22.5.2.2.

22.5.2.12 Battery Ram Opening and Closing Time. Measured opening and closing times of the ram shall be done as follows:

(1) Unloaded at the temperature specified in 22.4.3.1
(2) Unloaded at the temperatures specified in 22.6.1
(3) During cycles as defined in 22.6.8

22.5.2.13 Battery-Powered Ram Run Time. For rams, report the number of cycles as defined in 22.6.8 on one fully charged battery.

22.5.3 Combination Tools.

22.5.3.1 Operating Temperature Test.

22.5.3.1.1 Combination tools shall be tested for operating temperature range as specified in 22.6.1.

22.5.3.1.2 Combination tools shall operate for five operational cycles during operating temperature testing.

22.5.3.1.3 Combination tools shall perform without any defect or leak during operating temperature testing.

22.5.3.2 Combination tools shall be tested for their ability to hold spreading force as specified in 22.6.6, and not have a creep value greater than 5 mm (3⁄16 in.) at 9 minutes.

22.5.3.3 Where combination tools are also rated for pulling, those combination tools shall be tested for ability to hold pulling force as specified in 22.6.7, and not have a creep value greater than 5 mm (3⁄16 in.) at 9 minutes.

22.5.3.4 Combination tools shall be tested for their ability to cut through the materials as specified in 22.6.13, and cut the material in each material category at a minimum of Level 1 performance.

22.5.3.4.1 The combination tool cutter shall receive a separate level rating for each material category as determined by 12 pieces of the largest size material, indicated by the highest numerical performance level that the cutter is able to cut consecutively.

22.5.3.4.2* The minimum total number of qualified cuts that are required for certification shall be 60.

22.5.3.4.3 For each cut, the cutter shall completely sever the material in a single continuous motion.

22.5.3.4.4* The level rating for the cutter shall be expressed as specified in 22.4.4.4.2.

22.5.3.4.5 It shall be assumed that the cutter is capable of cutting all performance levels below its rated level in any specific materials category.

22.5.3.5 Integrity Test.

22.5.3.5.1 All mechanical parts of the cutter shall be tested for product integrity as specified in 22.6.14 and the following:

(1) Cutters shall sustain the maximum load that can be imparted from the force generated by the tool without damage.
(2) Cutters shall operate and cut.

22.5.3.5.2 For each cut, the cutter shall completely sever the material in a single continuous motion.

22.5.3.6 Combination tools shall be tested for spreading forces generated as specified in 22.6.2, and the spreading force at each of the 10 test points be at least 8900 N (2000 lbf).

22.5.3.6.1 The lowest recorded spreading force of all 10 test points shall be designated as the LSF for that specific tool.

22.5.3.6.2 The highest recorded spreading force of all 10 test points shall be designated as the HSF for that specific tool.

22.5.3.7 Combination tools shall be tested for pulling forces generated as specified in 22.6.4, and have the pulling force at each of the 10 test points be at least 7120 N (1600 lbf).

22.5.3.7.1 The lowest recorded pulling force of all 10 test points shall be designated as the LPF for that specific tool.

22.5.3.7.2 The highest recorded pulling force of all 10 test points shall be designated as the HPF for that specific tool.

22.5.3.8 Combination tools shall be tested for endurance as specified in 22.6.8, and not have a creep value greater than 5 mm (3⁄16 in.) at 9 minutes.

22.5.3.8.1* Where combination tool variants of the same basic design have different sources of power, each variant shall be tested for endurance as specified in 22.5.3.8.

22.5.3.8.2 A self-contained battery-powered combination tool shall be permitted to utilize an equivalent external power supply in place of the battery during endurance testing.

22.5.3.9 Overload Test.

22.5.3.9.1 Combination tools shall be tested for overload as specified in 22.6.9 and include the following:

(1) Combination tools shall not fail overload testing.
(2) Combination tools shall generate the HSF, ±8 percent, for the tool as determined in 22.5.3.6.

22.5.3.9.2 Where combination tools are also rated for pulling, those combination tools shall also generate the HPF, ±8 percent, for the tool as determined in 22.5.3.7.

22.5.3.10 Deadman Control Endurance Test.

22.5.3.10.1 The deadman control of combination tools shall be tested for endurance as specified in 22.6.10, and not have a creep value greater than 5 mm ($^{3}/_{16}$ in.) at 9 minutes.

22.5.3.10.2 Where combination tools are also rated for pulling, those combination tools shall also generate the HPF, ±8 percent, for the tool as determined in 22.5.3.7.

22.5.3.11 Where combination tools are equipped with a built-in automatic safety relief device in accordance with 22.4.1.5, combination tools shall be tested for correct functioning of the tool and the safety relief device as specified in 22.6.11, and operate as specified in 22.5.3.2.

22.5.3.12 Where combination tools are also rated for cutting high-strength materials, the cutters of those combination tool shall be tested for their ability to cut through the materials as specified in 22.6.15.

22.5.3.12.1 It shall not be required for the same combination tool used in 22.6.13 to be used in 22.6.15.

22.5.3.12.2 The combination tool shall receive a level rating as determined by six pieces of the largest size material, indicated by the highest performance level, that the cutter of the combination tool is able to cut consecutively.

22.5.3.12.3 For each cut, the combination tool shall completely sever the material in a single continuous motion.

22.5.3.12.4 The level rating for the combination tool shall be expressed as specified in 22.4.4.6.2.

22.5.3.12.5 It shall be assumed that the combination tool is capable of cutting all performance levels below its rated level.

22.5.3.13 Battery Combination Tool Opening and Closing Time. Measured opening and closing times of the combination tool shall be done as follows:

(1) Unloaded at temperature specified in 22.4.4.5
(2) Unloaded at temperatures specified in 22.6.1
(3) During cycles as defined in 22.6.8

22.5.3.14 Battery-Powered Combination Tool Run Time. For combination tools, report the number of cycles as defined in 22.6.8 on one fully charged battery.

22.5.4 Cutters.

22.5.4.1 Operating Temperature Test.

22.5.4.1.1 Cutters shall be tested for operating temperature range as specified in 22.6.1.

22.5.4.1.2 Cutters shall operate for five operational cycles during operating temperature testing.

22.5.4.1.3 Cutters shall perform without any defect or leak during operating temperature testing.

22.5.4.2 Cutters shall be tested for their ability to cut through the materials as specified in 22.6.13, as well as the material in each material category at a minimum of Level 1 performance.

22.5.4.2.1 The cutter shall receive a separate level rating for each material category as determined by 12 pieces of the largest size material, indicated by the highest numerical performance level, that the cutter is able to cut consecutively.

22.5.4.2.2* The minimum total number of qualified cuts that are required for certification shall be 60.

22.5.4.2.3 For each cut, the cutter shall completely sever the material in a single continuous motion.

22.5.4.2.4* The level rating for the cutter shall be expressed as specified in 22.4.5.3.2.

22.5.4.2.5 It shall be assumed that the cutter is capable of cutting all performance levels below its rated level in any specific materials category.

22.5.4.3 Integrity Test.

22.5.4.3.1 All mechanical parts of the cutter shall be tested for product integrity as specified in 22.6.14 and include the following:

(1) The cutter shall sustain the maximum load that can be imparted from the force generated by the tool without damage.
(2) The cutter shall operate and cut.

22.5.4.3.2 For each cut, the cutter shall completely sever the material in a single continuous motion.

22.5.4.4 The deadman control of cutters shall be tested for endurance as specified in 22.6.10 and include the following:

(1) The deadman control shall automatically return to neutral.
(2) The cutter shall develop the rated system input.

22.5.4.5 Where cutters are equipped with a built-in automatic safety relief device in accordance with 22.4.1.5, cutters shall be tested for functioning of the tool and the safety relief device as specified in 22.6.11 and include the following:

(1) The cutters shall operate without any sign of permanent damage, defect, or leaks.
(2) The cutter's safety relief device shall automatically reset.

22.5.4.6 Where cutters are also rated for cutting high-strength materials, those cutters shall be tested for their ability to cut through the materials as specified in 22.6.15.

22.5.4.6.1 It shall not be required for the same cutter used in 22.6.13 to be used in 22.6.15.

22.5.4.6.2 The cutter shall receive a level rating as determined by six pieces of the largest size material, indicated by the highest performance level, that the cutter is able to cut consecutively.

22.5.4.6.3 For each cut, the cutter shall completely sever the material in a single continuous motion.

22.5.4.6.4 The level rating for the cutter shall be expressed as specified in 22.4.5.5.2.

22.5.4.6.5 It shall be assumed that the cutter is capable of cutting all performance levels below its rated level.

22.5.4.7 Battery Cutter Opening and Closing Time. Measured opening and closing times of the cutter shall be done as follows:

(1) Unloaded at the temperature specified in 22.4.5.1
(2) Unloaded at temperatures specified in 22.6.1
(3) During cycles as defined in 22.6.8

22.5.4.8 Battery-Powered Cutter Run Time. For cutters, report the number of cuts of the cutter's rated profile A, Round Bar, as defined 22.6.13 on one fully charged battery.

22.5.5 Hose Assemblies. Hose assemblies shall be proof pressure tested as specified in 22.6.26, and not leak or rupture.

22.5.6 Power Units.

22.5.6.1 Where power units are tested using the rated system input, the rated system input shall have a tolerance ±5 percent.

22.5.6.2 The power unit shall be tested for impact resistance as specified in 22.6.16 and develop the rated system input of a rescue tool during each of five operational cycles.

22.5.6.3 The power unit shall be tested for noise production as specified in 22.6.17, and not exceed 83 dBA at 4 m (13 ft).

22.5.6.4 The power unit shall be tested for operation on an incline as specified in 22.6.18 and power a rescue tool through a complete operational cycle to the rated system input of the rescue tool.

22.5.6.5 The power unit hydraulic pump shall be tested for its ability to maintain rated system input as specified in 22.6.19 and maintain the rated system input for at least 1 minute.

22.5.6.6 The power unit output pressure relief or automatic limiting device shall be tested for proper operation as specified in 22.6.20 and prevent the power unit output from achieving greater than 105 percent of the rated system input.

22.5.6.7 The manually operated dump valve of power units shall be tested for proper operation as specified in 22.6.21, and allow hose to be disconnected from and reconnected to the power unit.

22.5.6.8 Power units shall be tested for endurance as specified in 22.6.22 and include the following:

(1) Power units shall operate normally.
(2) Power units shall not leak.

22.5.6.9 Directional valves on power units, where provided, shall be tested for endurance as specified in 22.6.23 and include the following:

(1) Directional valves shall operate normally.
(2) Directional valves shall not leak.

22.5.7 Remote Valve Blocks and Hose Reels.

22.5.7.1 Remote valve blocks shall be tested for endurance as specified in 22.6.24 and include the following:

(1) Remote valve blocks shall operate as intended.
(2) Remote valve blocks shall not leak.

22.5.7.2 Endurance Test.

22.5.7.2.1 Hose reels shall be tested for endurance as specified in 22.6.25.

22.5.7.2.2 Hose reel rotary seals shall not leak.

22.6 Testing.

22.6.1 Tool Operating Temperature Test.

22.6.1.1 Temperature Conditioning.

22.6.1.1.1 The tool test specimen, including the power unit designed to be used in conjunction with the specific tool and all hose and cables necessary to connect the power unit to the tool, shall be placed in a temperature-conditioning chamber at –20°C, ±2°C (–4°F, ±4°F) for a minimum of 5 hours.

22.6.1.1.2 The 5-hour storage time stated in 22.6.1.1.1 shall begin when the temperature-conditioning chamber has stabilized at –20°C, ±2°C (–4°F, ±4°F) after the tool test specimen has been placed in the chamber.

22.6.1.2 Removal from Chamber.

22.6.1.2.1 The tool test specimen shall be removed from the temperature-conditioning chamber after being subjected to at least 5 hours at the conditioning temperature.

22.6.1.2.2 The tool test specimen shall then be started within 2 minutes of removal from the temperature-conditioning chamber and be operated for five full cycles from the fully open to the fully closed position at rated system input.

22.6.1.3 The tool test specimen, power unit, hose, and cables shall be observed for defects and leaks while the tool test specimen is in operation.

22.6.1.4 Dwell Time.

22.6.1.4.1 After a 12-hour minimum dwell time, the same tool test specimen, including the power unit designed to be used in conjunction with the specific tool and all hose and cables necessary to connect the power unit to the tool, shall then be stored in a temperature-conditioning chamber at 49°C, ±2°C (120°F, ±4°F) for a minimum of 5 hours.

22.6.1.4.2 The 5-hour storage time stated in 22.6.1.4.1 shall begin when the temperature-conditioning chamber has stabilized at 49°C, ±2°C (120°F, ±4°F) after the tool test specimen has been placed in the chamber.

22.6.1.5 Second Removal from Chamber.

22.6.1.5.1 The tool test specimen shall be removed from the temperature-conditioning chamber after being subjected to at least 5 hours at the conditioning temperature.

22.6.1.5.2 The tool test specimen shall then be started within 2 minutes of removal from the temperature-conditioning chamber and be operated for five full cycles from the fully open to the fully closed position at rated system input.

22.6.1.6 The tool test specimen, power unit, hose, and cables shall be observed for defects and leaks while the tool test specimen is in operation.

22.6.1.7 The results of observation of all test cycles shall be used to determine pass/fail.

22.6.1.8 During any of the test cycles, any operational abnormalities, defects, or leaks in the tool, power unit, hose, or cables shall constitute failure.

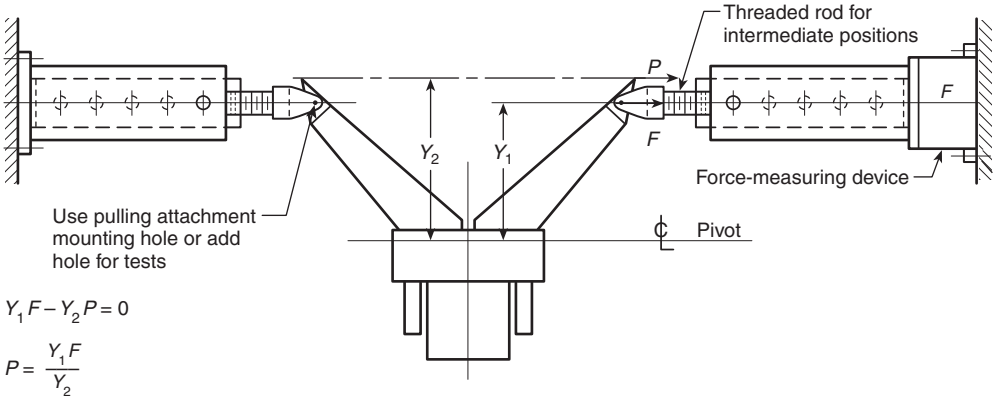
22.6.2 Spreading Force Test.

22.6.2.1 The spreading forces of tool test specimens shall be measured using a test fixture that allows the tool test specimen to move through its full operational cycle.

22.6.2.2 The test fixture shall be equipped with a calibrated force-measuring device, with a minimum accuracy of ±0.5 percent of the total scale reading, to record the forces developed.

22.6.2.3 Test Setup.

22.6.2.3.1 The general test setup shall be as shown in Figure 22.6.2.3.1(a) or Figure 22.6.2.3.1(b), as applicable.

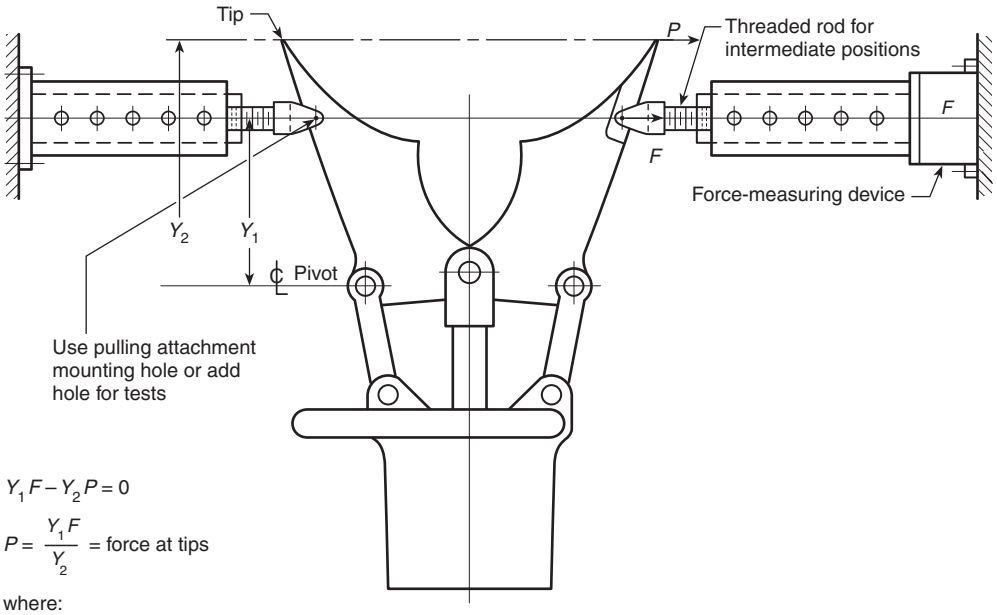


$Y_1 F - Y_2 P = 0$

$P = \frac{Y_1 F}{Y_2}$

where:
Y_1 = moment arm length of the measured force F
F = measured force at the attachment points
Y_2 = moment arm length of the calculated force P
P = calculated force at the tips

FIGURE 22.6.2.3.1(a) Test Fixture to Determine Spreading and Retracting Forces of Spreaders.



$Y_1 F - Y_2 P = 0$

$P = \frac{Y_1 F}{Y_2}$ = force at tips

where:
Y_1 = moment arm length of the measured force F
F = measured force at the attachment points
Y_2 = moment arm length of the calculated force P
P = calculated force at the tips

FIGURE 22.6.2.3.1(b) Test Fixture to Determine Spreading and Retracting Forces of Combination Tools.

22.6.2.3.2 Equivalent test setups that use the same concepts as shown in Figure 22.6.2.3.1(a) or Figure 22.6.2.3.1(b) shall be permitted.

22.6.2.3.3 The test points shall be the existing holes in the tool for pulling attachments.

22.6.2.3.4 Where there are no pulling attachment holes in the tool or test attachments supplied by the manufacturer, holes shall be made for conducting this test.

22.6.2.4 The tool test specimen shall be operated at the rated system input of the tool.

22.6.2.5 The spreading force exerted by the tool test specimen shall be measured and recorded at 10 uniformly spaced intervals that range from the fully closed position to 95 percent of the fully open position.

22.6.2.6 The recorded spreading forces shall be used to calculate the spreading force at the tool tip using the following formula:

[22.6.2.6]

$$\text{Minor diameter tolerance} = 2 \times \text{pitch diameter tolerance}$$

where:
P = calculated force at the tips
Y_1 = moment arm length of the measured force F
F = measured force at the attachment points
Y_2 = moment arm length of the calculated force P

22.6.2.7 Any calculated spreading force at the tool tips less than 8900 N (2000 lbf) shall constitute failure.

22.6.2.8 The calculated spreading forces at the tool tips shall be reviewed to determine the lowest spreading force (LSF) and highest spreading force (HSF) designations, respectively.

22.6.2.9 The calculated spreading forces at the tool tips shall be the reported forces that are required by 22.5.1.4 and 22.5.3.6.

22.6.3 Ram Tool Spreading Force Test.

22.6.3.1 The spreading forces of the tool test specimens shall be measured using the tips normally supplied to the purchaser or user.

22.6.3.2 A test fixture shall be provided.

22.6.3.2.1 The test fixture shall be equipped with a force-measuring device and allow the tool test specimen to move through its full operational cycle.

22.6.3.2.2 The test fixture shall be equipped with a calibrated force-measuring device, with a minimum accuracy of ±0.5 percent of the total scale reading, to record the forces developed.

22.6.3.3 Test Setup.

22.6.3.3.1 The general test setup shall be as shown in Figure 22.6.3.3.1, as applicable.

22.6.3.3.2 Equivalent test setups that use the same concept as shown in Figure 22.6.3.3.1 shall be permitted.

22.6.3.3.3 The test points shall be the existing holes in the tool for pulling attachments.

22.6.3.3.4 Where there are no pulling attachment holes in the tool, holes shall be made for conducting this test.

22.6.3.4 The ram tool test specimen shall be operated at the rated system input of the tool.

22.6.3.5 The spreading force exerted by the ram shall be measured and recorded at three uniformly spaced intervals that range from the fully closed position to 95 percent of the fully open position.

22.6.3.6 Pass/Fail.

22.6.3.6.1 The recorded spreading forces shall be reviewed to determine pass/fail.

22.6.3.6.2 Any recorded spreading force less than 8900 N (2000 lbf) shall constitute failure.

22.6.3.7 The recorded spreading forces shall be reviewed to determine the LSF and HSF designations, respectively.

22.6.3.8 The recorded spreading forces at the tool tips shall be the reported forces required by 22.5.2.5.

22.6.4 Spreader Tool Pulling Force Test.

22.6.4.1 The pulling forces of tool test specimens shall be measured using the tips normally supplied to the purchaser or user.

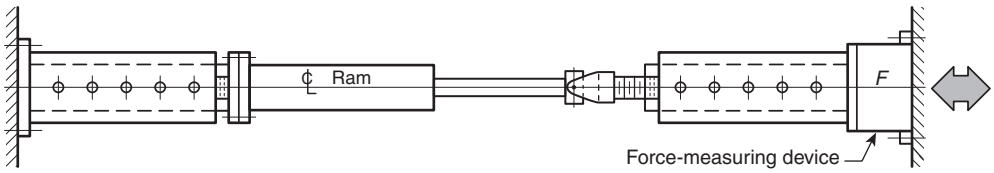
22.6.4.2 A test fixture shall be provided that allows the tool test specimen to move through its full operational cycle.

22.6.4.3 The test fixture shall be equipped with a calibrated force-measuring device, with a minimum accuracy of ±0.5 percent of the total scale reading, to record the forces developed.

22.6.4.4 Test Setup.

22.6.4.4.1 The general test setup shall be as shown in Figure 22.6.2.3.1(a) or Figure 22.6.2.3.1(b), as applicable.

22.6.4.4.2 Equivalent test setups that use the same concept as shown in Figure 22.6.2.3.1(a) or Figure 22.6.2.3.1(b) shall be permitted.



F = measured force at attachment points

FIGURE 22.6.3.3.1 Test Fixture to Determine Extension and Retraction Forces of Rams.

22.6.4.5 The test points shall be the standard production pulling attachment points on the rescue tool.

22.6.4.6 The tool test specimen shall be operated at the rated system input of the tool.

22.6.4.7 The pulling force exerted by the tool test specimen shall be measured and recorded at 10 uniformly spaced intervals that range from the fully open position to 95 percent of the fully closed position.

22.6.4.8 The reported pulling forces at the tool tips shall be reviewed to determine pass/fail and to determine the lowest pulling force (LPF) and highest pulling force (HPF) designations, respectively.

22.6.4.9 The recorded pulling forces shall be the reported forces required by 22.5.1.5 and 22.5.3.7.

22.6.5 Ram Tool Pulling Force Test.

22.6.5.1 The pulling forces of tool test specimens shall be measured using the tips normally supplied to the purchaser or user.

22.6.5.2 A test fixture shall be provided.

22.6.5.2.1 The test fixture shall be equipped with a force-measuring device and allow the tool test specimen to move through its full operational cycle.

22.6.5.2.2 The test fixture shall be equipped with a calibrated force-measuring device, with a minimum accuracy of ±0.5 percent of the total scale reading, to record the forces developed.

22.6.5.3 Test Setup.

22.6.5.3.1 The general test setup shall be as shown in Figure 22.6.3.3.1, as applicable.

22.6.5.3.2 Equivalent test setups of the same concept as shown in Figure 22.6.3.3.1 shall be permitted.

22.6.5.4 The test points shall be the standard production pulling attachment points on the rescue tool.

22.6.5.5 The ram tool test specimen shall be operated at the rated system input of the tool.

22.6.5.6 The pulling force exerted by the ram shall be measured and recorded at three uniformly spaced intervals that range from the fully open position to 95 percent of the fully closed position.

22.6.5.7 The recorded pulling forces shall be reviewed to determine pass/fail and the LPF and HPF designations, respectively.

22.6.5.8 The recorded pulling forces at the tool tips shall be the reported forces required by 22.5.2.6.

22.6.6 Spreading Force Sudden Power Loss Test.

22.6.6.1 Tool test specimens shall be placed in the test fixture exactly as for the spreading force test specified in 22.6.2 or 22.6.3, as applicable for the specific tool test specimen.

22.6.6.2 Tool test specimens shall be set at the HSF position and be subjected to an external load equal to the greatest spreading force measured in the respective spreading force test, ±2 percent.

22.6.6.3 The pressure supply hose or electric cable that supplies the tool test specimen shall then be disconnected from the tool to simulate a sudden power loss, and any creep of the tool test specimen be measured.

22.6.6.3.1 Where the tool test specimen is not equipped with a control, the creep shall be measured at 9 minutes.

22.6.6.3.2 Where the tool test specimen is equipped with a control, the control shall be set at each setting during the test.

22.6.6.3.2.1 The control setting shall be set for 3 minutes at fully open, 3 minutes at fully closed, and 3 minutes at neutral.

22.6.6.3.2.2 The creep shall be measured at 9 minutes.

22.6.6.4 Pass/Fail.

22.6.6.4.1 The measured creep shall be evaluated to determine pass/fail.

22.6.6.4.2 Any creep that exceeds the requirement shall constitute failure.

22.6.7 Pulling Force Sudden Power Loss Test.

22.6.7.1 Tool test specimens shall be placed in the test fixture exactly as for the pulling force test specified in 22.6.4 or 22.6.5, as applicable for the specific tool test specimen.

22.6.7.2 Tool test specimens shall be set at the HPF position and be subjected to an external load equal to the greatest pulling force measured in the respective pulling force test, ±2 percent.

22.6.7.3 The pressure supply hose or electric cable that supplies the tool test specimen shall then be disconnected from the tool to simulate a sudden power loss, and any creep of the tool test specimen be measured.

22.6.7.3.1 The tool test specimen control shall be set at each setting during the test.

22.6.7.3.2 The control setting shall be set for 3 minutes at fully open, 3 minutes at fully closed, and 3 minutes at neutral.

22.6.7.3.3 The creep shall be measured at 9 minutes.

22.6.7.4 Pass/Fail.

22.6.7.4.1 The measured creep shall be evaluated to determine pass/fail.

22.6.7.4.2 Any creep that exceeds the requirement at 9 minutes shall constitute failure.

22.6.8 Dynamic Endurance Test.

22.6.8.1 A test fixture shall be provided that allows the tool test specimen to move through its full operational cycle.

22.6.8.2 The test fixture shall be equipped with a calibrated force-measuring device, with a minimum accuracy of ±0.5 percent of the total scale reading, to record the forces developed.

22.6.8.3 Test Setup.

22.6.8.3.1 The general test setup shall be as shown in Figure 22.6.2.3.1(a) or Figure 22.6.2.3.1(b), as applicable.

22.6.8.3.2 Equivalent test setups that use the same concept as shown in Figure 22.6.2.3.1(a) or Figure 22.6.2.3.1(b) shall be permitted.

22.6.8.4 Cooling of the hydraulic fluid, electric motor, and electric switches shall be permitted during this test.

22.6.8.5 The tool test specimens for spreading and pulling shall undergo 1000 continual operational cycles while under a spreading load equal to 80 percent of the LSF and while under a pulling load equal to 80 percent of the LPF, as defined in 22.5.1.4, 22.5.1.5, 22.5.2.5, 22.5.2.6, 22.5.3.6, or 22.5.3.7, as applicable for the specific tool test specimen.

22.6.8.5.1 A pause in the continual operational cycles for lubrication shall be permitted.

22.6.8.5.2 The continual operational cycles shall not be interrupted for maintenance other than as allowed by 22.6.8.5.1.

22.6.8.6 The tool test specimens shall then be placed in the same test fixture exactly as for the load test specified in 22.6.2 or 22.6.3, as applicable for the specific tool test specimen.

22.6.8.6.1 Tool test specimens shall be subjected to a test load equal to 110 percent of the HSF of the specific tool.

22.6.8.6.2 Where tools also are rated for pulling, those tool test specimens shall also be subjected to a test load equal to 110 percent of the HPF of the specific tool.

22.6.8.7 The pressure supply hose or electrical cables supplying the tool test specimen shall then be disconnected from the tool to simulate a sudden power loss, and any creep of the tool test specimen shall be measured.

22.6.8.7.1 Where the tool test specimen is not equipped with a control, the creep shall be measured at 9 minutes.

22.6.8.7.2 Where the tool test specimen is equipped with a control, the control shall be set at each setting during the test.

22.6.8.7.2.1 The control setting shall be set for 3 minutes at fully open, 3 minutes at fully closed, and 3 minutes at neutral.

22.6.8.7.2.2 The creep shall be measured at 9 minutes.

22.6.8.8 Pass/Fail.

22.6.8.8.1 The measured creep shall be evaluated to determine pass/fail.

22.6.8.8.2 Any creep that exceeds the requirement at 9 minutes shall constitute failure.

22.6.9 Overload Test.

22.6.9.1 While the tool test specimen is in the test fixture used for the test specified in 22.6.2 or 22.6.3, as applicable for the specific tool test specimen, a test load equal to 150 percent of the HSF and HPF, as applicable, shall be applied as stated in 22.6.9.1.1 through 22.6.9.1.3 for one minute.

22.6.9.1.1 For rescue tools having external pressure supply and return ports, the test load shall be achieved by applying 150 percent of the rated system input.

22.6.9.1.2 Rescue tools having self-contained internal pressure supply and return ports (i.e., closed-loop systems) shall be permitted to be tested in accordance with the procedures specified in either 22.6.14.2 or 22.6.14.4.

22.6.9.1.3 For rescue tools that do not meet the criteria of 22.6.9.1.1 or 22.6.9.1.2, the test load shall be applied externally.

22.6.9.2 Spreader Tool or Combination Test Specimens.

22.6.9.2.1 For spreader tool or combination tool test specimens, the test load shall be applied to the tool at the tip separation producing the HSF as determined in 22.5.1.4 or 22.5.3.6.

22.6.9.2.2 Where the tool is also rated for pulling, the test load shall be applied to the tool at the tip separation producing the HPF as determined in 22.5.1.5 or 22.5.3.7.

22.6.9.3 Ram Tool Test Specimens.

22.6.9.3.1 For ram tool test specimens, the test load shall be applied to the tool at the tip separation producing the HSF as determined in 22.5.2.5.

22.6.9.3.2 Where the ram tool is also rated for pulling, the test load shall be applied to the tool at the tip separation producing the HPF as determined in 22.5.2.6.

22.6.9.4 The test results shall be evaluated and the tool test specimen shall be examined and operated to determine pass/fail.

22.6.9.4.1 The inability of a tool to produce the HSF or HPF, or both, as applicable, shall constitute failure.

22.6.9.4.2 The inability of a tool to be fully operational from the fully open position to the fully closed position back to the fully open position shall constitute failure.

22.6.10 Deadman Control Device Endurance Test.

22.6.10.1 The deadman control on the tool test specimen shall be subjected to a continual 5000-cycle endurance test during which fluid must be circulated through the tool, or current applied, so as to cause the tool to move in both the opening and closing directions.

22.6.10.1.1 The tool shall be operated a distance equal to no less than 10 percent of the total travel distance of the tool in each direction during each activation.

22.6.10.1.2 No external mechanical load, or resistance, shall be applied to the tool.

22.6.10.2 A cycle for this test shall be the activation of the control to its hard stop in each direction so as to cause the tool test specimen to move in the opening and closing directions as specified in 22.6.10, and then releasing the control, allowing the control to return to its neutral position.

22.6.10.3 Controls.

22.6.10.3.1 Where all deadman controls on the tool test specimen are identical, a single test with one tool shall be conducted.

22.6.10.3.2 Each different type of deadman control shall be tested separately.

22.6.10.4 Following the 5000 cycles, the deadman control shall be evaluated to determine that it has automatically returned to the neutral position.

22.6.10.5 For spreaders, rams, and combination tools, the tool test specimen shall then be evaluated in accordance with 22.6.6.

22.6.10.5.1 The measured creep shall be evaluated to determine pass/fail.

22.6.10.5.2 Any creep that exceeds the requirement at 9 minutes shall constitute failure.

22.6.10.5.3 Tool Test Specimen.

22.6.10.5.3.1 The tool test specimen shall be examined and operated to determine pass/fail.

22.6.10.5.3.2 The inability of a tool to produce the HSF or HPF, or both, as applicable, shall constitute failure.

22.6.10.6 For cutters, the tool test specimen shall then be evaluated in accordance with 22.6.14.

22.6.11 Safety Relief Device Test.

22.6.11.1 The pressure and return lines shall be connected to the tool, and the return line from the tool shall be blocked.

22.6.11.2 The power unit shall be activated, and the tool be operated with the piston rod extending for 15 seconds to the rated system input.

22.6.11.3 Return Line Blockage.

22.6.11.3.1 For spreaders, rams, and combination tools, the return line shall then be unblocked and the tool be tested as specified in 22.6.6.

22.6.11.3.2 Testing in accordance with 22.6.8 shall be permitted to be performed only once to evaluate the requirements in both 22.6.6 and 22.6.11.

22.6.11.4 For spreaders, rams, and combination tools, pass/fail shall be determined as specified in 22.5.1.2, 22.5.2.2, and 22.5.3.2, respectively.

22.6.11.5 For cutters, the return line shall then be unblocked, and the cutter be operated for five complete operational cycles to the rated system input.

22.6.11.6 For cutters, pass/fail shall be determined in accordance with 22.5.4.5.

22.6.12 Ram Bend Test.

22.6.12.1 The ram tool test specimen shall be tested at 95 percent of the full extension as shown in Figure 22.6.12.1.

22.6.12.2 An external off-center load equal to 125 percent of the spreading force measured at 95 percent of its full extension in 22.6.3.6 shall be applied to the ram while the ram is extended to 95 percent of its stroke.

22.6.12.3 The load shall be applied at a point not more than 13 mm (½ in.) from the farthest edge of the gripping surfaces of the feet and in the same radial plane.

22.6.12.4 Leakage.

22.6.12.4.1 The tool test specimen shall be examined for leakage to determine pass/fail.

22.6.12.4.2 Any leakage shall constitute failure.

22.6.12.5 Tool Test Specimen.

22.6.12.5.1 The tool test specimen shall be operated to determine pass/fail.

22.6.12.5.2 The inability of a tool to produce the HSF or HPF, or both, as applicable, shall constitute failure.

22.6.13 Cutting Test.

22.6.13.1 The purpose of the cutting test shall be to provide a benchmark for comparison of cutting capabilities as it relates to 22.6.13.3.

22.6.13.2 The cutting test shall not be an indication of a cutter's performance in the field.

22.6.13.3 The tool test specimen shall be operated to cut 12 pieces of the largest size material, indicated by the highest numerical performance level, which it is capable of cutting for each material category specified in Figure 22.6.13.3.

22.6.13.4 Each tool test specimen shall use only one set of blades for this test.

22.6.13.5 Cutting shall be permitted to be performed at any area of the blades.

22.6.13.6 The minimum total number of qualified cuts required for certification shall be 60; that is, 12 cuts at the same performance level for a single material category and repeated for all material categories.

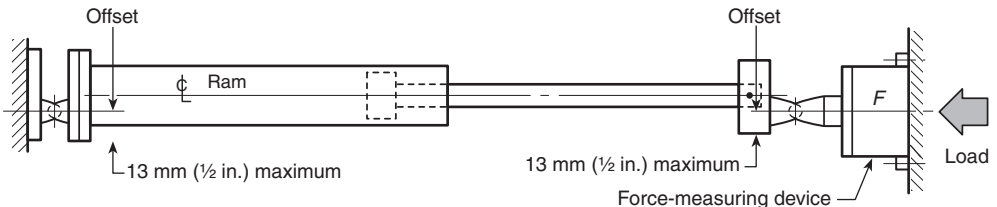
22.6.13.7 The performance level shall be the same for all 12 cuts of a single material category but be permitted to be a different performance level for each material category.

22.6.13.8 Each cut shall be observed to determine that the cutter completely severs the material in a single continuous motion to determine pass/fail.

22.6.13.9 The number of pieces of material that are cut shall be tabulated to determine pass/fail.

22.6.13.10 The performance level at which the cutter cuts each material category shall be recorded and reported to determine the level rating for the cutter.

22.6.13.11 The inability of a cutter to cut through the materials at a minimum of performance Level 1 in each of the five material categories shall constitute failure of the cutter.



F = measured force at the attachment points (N)

FIGURE 22.6.12.1 Fixture for Ram Bend Test.

Material Category	A Round Bar	B Flat Bar	C Round Pipe		D Square Tube	E Angle Iron
						
Material	A-36 Hot-Rolled	A-36	Schedule 40 A-53 Grade B		A-500 Grade B	A-36
Performance Level	Diameter (in.)	Thickness × Width (in. × in.)	Nominal size (in.)	OD × Wall Thickness (in. × in.)	Dimension × Wall Thickness (in. × in.)	Square Dimension × Thickness (in. × in.)
1	⅜	¼ × ½	⅜	0.68 × 0.09	½ × 0.06	½ × ⅛
2	½	¼ × 1	¾	1.05 × 0.11	1¾ × 0.06	1 × ⅛
3	⅝	¼ × 2	1	1.32 × 0.13	1 × 0.08	1¼ × 3⁄16
4	¾	¼ × 3	1¼	1.66 × 0.14	1¼ × 0.12	1½ × 3⁄16
5	⅞	¼ × 4	1½	1.90 × 0.15	1½ × 0.12	1½ × ¼
6	1	⅜ × 3	2	2.38 × 0.15	1¾ × 0.12	1¾ × ¼
7	1¼	⅜ × 4	2½	2.88 × 0.20	2 × 0.15	1½ × ⅜
8	1½	⅜ × 5	3	3.50 × 0.22	2½ × 0.19	2 × ⅜
9	1¾	⅜ × 6	3½	4.00 × 0.23	3 × 0.19	2½ × ⅜

For SI units 1 in. = 25.4 mm.

FIGURE 22.6.13.3 Cut Testing and Level Performance Rating.

22.6.14 Cutter Integrity Test.

22.6.14.1 The tool test specimen shall be operated in accordance with the manufacturer's instructions.

22.6.14.2 For rescue tools having external pressure supply and return ports, the cutter shall be pressurized to 150 percent of the rated system input and caused to cut into a steel rod that is beyond the tool's cutting capacity for 1 minute.

22.6.14.3 Rescue tools having self-contained internal pressure supply and return ports (i.e., closed-loop systems) shall be permitted to be tested in accordance with the procedures specified in either 22.6.14.2 or 22.6.14.4.

22.6.14.4 The rescue tool cutter shall be connected to a force-measuring device and operated at rated system input to cut into steel that is beyond the cutting capacity of the cutter.

22.6.14.4.1 The force achieved by the cutter shall be recorded.

22.6.14.4.2 With the cutter blades still engaged into the steel, an opposing external force equal to 1.5 times the achieved force shall be applied for 1 minute.

22.6.14.5 Following the overload condition, the cutters shall be operated for a single cut of each material category at the performance level for which the cutter is rated.

22.6.14.5.1 For each cut, the cutter shall completely sever the material in a single continuous motion.

22.6.14.5.2 Cutting shall be permitted to be performed at any area of the blades.

22.6.14.5.3 The power unit shall be returned to the normal operating pressure so that it will not exceed the rated system input pressure needed to perform the following test cuts.

22.6.14.6 The cutting process shall be evaluated to determine pass/fail.

22.6.15 High-Strength Material Cutting Test.

22.6.15.1* This test shall apply only to cutters and combination tools where the manufacturer is rating them for cutting high-strength materials *(see Figure 22.6.15.1)*.

22.6.15.2 The cutting test shall be a benchmark for comparison of cutting capabilities as it relates to Figure 22.6.15.1.

22.6.15.3 The cutting test shall not be an indication of a cutter's performance in the field.

22.6.15.4 Operation.

22.6.15.4.1 The tool test specimen shall be operated to cut six pieces of the largest size material, indicated by the highest performance level, that it is capable of cutting as specified in Figure 22.6.15.1.

22.6.15.4.2 The cutter blades shall be placed a minimum of 100 mm (3.9 in.) distance from each end of the cut test material.

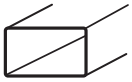
22.6.15.5 Each tool test specimen shall use only one set of blades for this test.

22.6.15.6 Cutting shall be permitted to be performed at any area of the blades.

22.6.15.7 The minimum number of qualified cuts required to achieve rating for high-strength materials shall be 6.

22.6.15.8 Each cut shall be observed to determine that the cutter completely severs the material in a single continuous motion to determine rating for high-strength materials.

22.6.15.9 The number of pieces of material that are cut shall be tabulated to determine rating for high-strength materials.

Material Category	F Rectangular Tube Ultra High-Strength Low-Alloy 
Material	4130 per AMS 6371 H/T to min 32 HRC Profile per ASTM A519/A519M

Performance Level	Outside Dimensions × Wall Thickness	
	mm × mm × mm	in. × in. × in.
1	25 × 50 × 1.7	1 × 2 × 0.065
2	25 × 50 × 2.1	1 × 2 × 0.083
3	25 × 50 × 3.04	1 × 2 × 0.120
4	50 × 76 × 3.178	2 × 3 × 0.125
5	50 × 76 × 4.78	2 × 3 × 0.188
6	50 × 101 × 4.78	2 × 4 × 0.188
7	50 × 101 × 6.4	2 × 4 × 0.250

FIGURE 22.6.15.1 High-Strength Materials Cut and Level Performance Rating.

22.6.15.10 The performance level at which the material is successfully severed shall be recorded and reported to determine the level rating for the cutter.

22.6.15.11 A cutter that is unable to cut the lowest performance level for high-strength materials shall not be rated for cutting high-strength materials.

22.6.15.12 The inability of the cutter to cut the lowest performance level shall not constitute failure of the cutter to qualify for certification to this standard.

22.6.16 Impact Resistance Test.

22.6.16.1 The power unit test specimen shall be suspended in an upright orientation over a solid steel plate that is at least 25 mm (1 in.) thick.

22.6.16.2 The power unit test specimen shall be dropped a distance of 610 mm (2 ft) onto the steel plate.

22.6.16.3 The power unit test specimen shall then be connected to a tool that is designated for use with the power unit and power the tool through five complete operational cycles of the tool.

22.6.16.4 The rated system input of the tool that is achieved while being powered by the power unit test specimen during each of the five cycles shall be recorded to determine pass/fail.

22.6.17 Noise Test.

22.6.17.1 The test procedure shall be conducted in accordance with ANSI S12.36, *Standard Survey Methods for the Determination of Sound Pressure Levels of Noise Sources*.

22.6.17.2 The noise produced by the power unit test specimens shall be measured at a distance of 4 m (13 ft) from the power unit.

22.6.17.3 The noise production shall be recorded and evaluated to determine pass/fail.

22.6.18 Incline Operational Test.

22.6.18.1 Test Specimen.

22.6.18.1.1 The power unit test specimen shall be tested while powering a rescue tool with the largest differential oil volume that is capable of being used with the system.

22.6.18.1.2 The rescue tool used in this test shall be designated for use with the power unit test specimen.

22.6.18.2 The power unit test specimen shall be inclined to a 15-degree angle in one of the four horizontal axial directions ±1 percent.

22.6.18.3 The power unit test specimen shall then power the tool through a single operational cycle to the tool's rated system input.

22.6.18.4 The rated system input that is achieved shall be recorded and evaluated to determine pass/fail.

22.6.18.5 The power unit test specimen shall then be inclined to a 15-degree angle in the second, third, and fourth horizontal axial directions.

22.6.18.6 The power unit test specimen shall then power the tool to the tool's rated system input through an additional single operational cycle for each additional 15-degree horizontal axial direction.

22.6.18.7 The rated system input that is achieved in each of the additional 15-degree horizontal axial directions shall be recorded and evaluated to determine pass/fail.

22.6.19 Power Unit Pressure Test.

22.6.19.1 Power unit test specimens shall be tested on a level surface, and the system input shall be monitored by a gauge.

22.6.19.2 Operation.

22.6.19.2.1 Power unit test specimens shall be operated at the rated system input designated for the specific power unit.

22.6.19.2.2 The rated system input shall be maintained for 1 minute.

22.6.19.3 During the 1-minute test specified in 22.6.19.2 and 22.6.19.2.1, the gauge shall be observed for any fluctuation to determine pass/fail.

22.6.19.4 Pressure fluctuation during the 1-minute test, if any, shall not be more than ±5 percent of the rated system input.

22.6.20 Power Unit Pressure Relief and Automatic Limiting Device Test.

22.6.20.1 The output safety pressure relief valve or automatic limiting device of the power unit test specimen shall be set at the rated system input.

22.6.20.2 Testing.

22.6.20.2.1 Power unit test specimens shall be tested on a level surface.

22.6.20.2.2 The system input shall be monitored by a gauge.

22.6.20.3 Input Level.

22.6.20.3.1 The system input of the power unit test specimen shall be raised until the pressure relief or automatic shutoff device operates.

22.6.20.3.2 This test cycle shall be repeated for a total of 10 cycles.

22.6.20.4 The system input at which the pressure relief or automatic shutoff device operates shall be recorded for each of the 10 test cycles.

22.6.20.5 The recorded system input at which the pressure relief or automatic shutoff device operates shall be evaluated to determine pass/fail.

22.6.21 Power Unit Dump Valve Test.

22.6.21.1 The dump valve of the power unit test specimen shall be tested at the maximum operating flow of the prime mover.

22.6.21.2 Supply Hose.

22.6.21.2.1 Power unit test specimens shall be tested on a level surface with the supply hose connected to a tool that is designated for use with the power unit test specimen.

22.6.21.2.2 The supply hose shall then be pressurized.

22.6.21.3 Dumping.

22.6.21.3.1 While the dump valve of the power unit test specimen is activated (i.e., open), the hose to the tool shall be disconnected.

22.6.21.3.2 The system then shall be repressurized and dumped again.

22.6.21.4 Reconnection.

22.6.21.4.1 The hose shall then be reconnected to the tool.

22.6.21.4.2 The reconnection shall be possible without causing pressurization in the couplers or causing other related problems.

22.6.21.5 The disconnection and reconnection of the hose shall be evaluated to determine pass/fail.

22.6.21.6 The tool shall operate normally after the hose has been reconnected.

22.6.22 Power Unit Endurance Test.

22.6.22.1 Testing.

22.6.22.1.1 Power unit test specimens shall be tested on a level surface.

22.6.22.1.2 The system input shall be monitored by a gauge.

22.6.22.2 The power unit test specimen shall generate the rated system input and be held at the rated system input for 20 seconds.

22.6.22.3 The power unit shall then be relieved of the rated system input for 20 seconds.

22.6.22.4 The duration of the test shall comprise one hundred 20-second rated system input "held"/20-second rated system input "relieved" cycles.

22.6.22.5 A pause shall be permitted as required for refilling the fuel tank or changing replaceable battery packs.

22.6.22.6 Cooling of the hydraulic fluid, electric motor, and electric switches shall be permitted during the test.

22.6.22.7 The power unit test specimen shall be observed during and immediately after completion of the test to check for leaks or malfunction to determine pass/fail.

22.6.23 Directional Valve Endurance Test.

22.6.23.1 The directional valve(s) of the power unit test specimen's hydraulic pump shall be subjected to a continual 5000-cycle endurance test during which fluid must be circulating through a connected tool, so as to cause the fluid to circulate through the hydraulic lines connecting it to the power unit.

22.6.23.1.1 A cycle for this test shall be defined as the activation of the directional valve(s) to its hard stop in each direction, and then returning the directional valve(s) to its neutral position.

22.6.23.1.2 It shall not be necessary to subject the directional valves to the rated system input pressure during the 5000 cycles.

22.6.23.2 Following the 5000 test cycles, the directional valve(s) shall be pressurized to 100 percent of the rated system input.

22.6.23.3 The directional valve(s) shall be observed for operation and leakage to determine pass/fail.

22.6.24 Remote Valve Block Endurance Test.

22.6.24.1 Remote valve block test specimens shall be subjected to a continual 5000-cycle endurance test during which fluid must be circulating through a connected tool, so as to cause the fluid to circulate through the hydraulic lines connecting it to the power unit.

22.6.24.1.1 A cycle for this test shall be defined as the activation of the directional valve(s) to its hard stop in each direction, and then returning the directional valve(s) to its neutral position.

22.6.24.1.2 It shall not be necessary to subject the remote valve block to reach the rated system input pressure during the 5000 system.

22.6.24.2 Following the 5000 test cycles, the remote valve blocks shall be pressurized to 100 percent of the rated system input.

22.6.24.3 The remote valve blocks shall be observed for leakage to determine pass/fail.

22.6.25 Hose Reel Endurance Test.

22.6.25.1 Cycles.

22.6.25.1.1 Hose reel test specimens shall be subjected to a 5000-cycle endurance test.

22.6.25.1.2 One cycle shall consist of one revolution in each direction.

22.6.25.2 After the 5000 test cycles, the rotary seal on the hose reel test specimen shall be pressurized to 100 percent of the maximum rated inlet pressure.

22.6.25.3 The rotary seal shall be observed for leakage to determine pass/fail.

22.6.26 Hose Assembly Proof Pressure Test.

22.6.26.1 The hose assembly shall be hydrostatic tested to 150 percent of the rated system input.

22.6.26.2 Duration.

22.6.26.2.1 The test pressure shall be maintained for 1 minute, +5 seconds/−0 seconds, and then released.

22.6.26.2.2 This procedure shall be performed twice in a 5-minute period.

22.6.26.3 The hose assembly shall be observed during and after the pressurization to determine pass/fail.

Chapter 23 Lifting Bags (NFPA 1936)

23.1 Administration.

23.1.1 Scope.

23.1.1.1 This chapter shall specify the minimum requirements for the design, performance, testing, and certification of air lifting bags and components.

23.1.1.2 Safety and Health.

23.1.1.2.1 This chapter shall not be construed as addressing all of the safety concerns, if any, associated with its use.

23.1.1.2.2 It shall be the responsibility of the persons and organizations that use this standard to establish safety and health practices and determine the applicability of regulatory limitations prior to use of this standard.

23.1.1.3 Nothing herein shall restrict any jurisdiction from specifying lifting bags and components that exceed the minimum requirements of this standard.

23.1.1.4 Nothing herein shall restrict any manufacturer from producing lifting bags and components that exceed the minimum requirements of this standard.

23.1.2 Purpose.

23.1.2.1 The purpose of this chapter shall be to establish minimum performance requirements for lifting bags and components that are utilized by emergency services personnel to facilitate the extrication of victims from entrapment.

23.1.2.2 Controlled laboratory environmental and physical tests are used to determine compliance with the performance requirements of this standard only; however, such tests shall not be deemed as establishing the performance levels of lifting bags and components for all situations.

23.1.2.3 This chapter is not intended to serve as a detailed manufacturing or purchase specification but shall be permitted to be referenced in purchase specifications as minimum acceptable requirements.

23.1.3 Application.

23.1.3.1 This chapter shall apply to the design, manufacturing, and certification of manufactured lifting bags and components.

23.1.3.2 The requirements of this chapter shall not apply to accessories that might be attached to lifting bags or components.

23.2 Product Labeling and Information.

23.2.1 Lifting Bags.

23.2.1.1 Each lifting bag shall have a product label permanently attached.

23.2.1.2 Each product label shall have the third-party certification organization's label, symbol, or identifying mark and at least the following compliance statement printed on the product label:

MEETS NFPA 1960, 2024 ED.

23.2.1.3 The following information also shall be printed on the product label following the compliance statement specified in 23.2.1.2:

(1) Manufacturer's name and/or identification mark
(2) Product identification number, lot number, or serial number
(3) Month and year of manufacture (not coded)
(4) Month and year of expiration, which should be no greater than 15 years after date of manufacture
(5) Model name, number, or design
(6) Lifting capacity (applicable units)
(7) Maximum working height/stroke (cm/in.)
(8) Allowable pressure (bar/psi)

23.2.1.4 More than one label piece shall be permitted to carry all statements and information required of the product label.

23.2.1.5 The legibility of the items in 23.2.1.3(5) through 23.2.1.3(7) shall comply with 23.4.2.4.

23.2.2 Control Devices. Control devices shall be marked with the manufacturer's name, manufacturer's model, all directions for operation, and maximum inlet pressure.

23.2.3 Manual Pumps. Manual pumps shall be marked with the manufacturer's name or identification mark, or both, and the manufacturer's model number.

23.3 User Information.

23.3.1 The lifting bag manufacturer shall provide a user manual with each lifting bag and component set, as described in 23.4.1.1.

23.3.2 The user manual shall be permitted to be in the form of printed, audiovisual, or web-based material, or any combination thereof.

23.3.3 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product labels where those symbols and pictorial graphic representations are explained in the user information.

23.3.4 The manual(s) shall provide, at a minimum, the following information:

(1) Manufacturer's name and address
(2) Source for service and technical information
(3) How or where parts can be obtained
(4) Setup procedures
(5) Operating instructions
(6) Safety considerations
(7) Limitations of use
(8) Inspection procedures
(9) Recommended maintenance procedures
(10) Troubleshooting guide
(11) Manufacturer's warranty
(12) Special requirements or data required by this standard
(13) Storage procedures

23.3.5 The lifting bag manufacturer shall specify in the manual the length, width, and height dimensions of all lifting bags and components to establish the minimum storage dimensions.

23.4 Design Requirements.

23.4.1 Lifting Bag System.

23.4.1.1 A lifting bag system shall include the following components:

(1) Hose or hose assemblies, or both
(2) Regulator
(3) Control device for each lifting bag
(4) Pressure indicator for each lifting bag
(5) Safety valve for each lifting bag
(6) Lifting bag(s)

23.4.1.2 Components of a lifting bag system shall be designed only to fit mating components that are intended for use with the same allowable pressure.

23.4.1.3 Components of a lifting bag system shall be capable of being operated within the ambient temperature range of −20°C to +55°C (−4°F to +131°F).

23.4.1.4 The lifting bag system shall be designed to limit the speed of descent to no more than 25 mm/sec (1 in./sec) when the lifting bag is supporting a load at allowable pressure.

23.4.2 Lifting Bags.

23.4.2.1 Each lifting bag type shall not show any loss of integrity or other structural failure when subjected to a pressure defined in Table 23.4.2.1.

23.4.2.2 The external or pressure containing material used in the construction of lifting bags shall resist penetration as specified in 23.5.14.

23.4.2.3 The connector incorporated into the lifting bag shall withstand an axial pulling force as specified in 23.5.16.

23.4.2.4 Legibility.

23.4.2.4.1 Lifting bag product labels shall be tested for legibility as specified in 23.6.16.

Table 23.4.2.1 Test Pressure

Allowable Pressure AP (in bar)	Pressure Volume (in bar liters)	Type Test Pressure	Individual or Production Test Pressure
1 bar or less	1500 or less	3 × AP	1.5 × AP
1 bar or less	Greater than 1500	4 × AP	1.5 × AP
Greater than 1 bar	1500 or less	4 × AP	1.5 × AP
Greater than 1 bar	Greater than 1500	4 × AP	1.5 × AP

23.4.2.4.2 Lifting bag product labels shall be able to be read by the unaided eye.

23.4.3 Hose Assemblies and Couplings.

23.4.3.1 Hose assemblies shall have a minimum safety factor against burst of 400 percent of rated hose pressure.

23.4.3.2 Quick-connect couplers shall require at least two separate manual actions to disconnect.

23.4.3.3 Rating.

23.4.3.3.1 All couplers and quick-connect couplers shall be rated for at least the rated system input.

23.4.3.3.2 All couplers and quick-connect couplers shall have a minimum safety factor of 400 percent of rated hose pressure.

23.4.3.4 All couplers and quick-connect couplers shall be able to be connected and disconnected while wearing gloves that are certified as compliant with the glove requirements of NFPA 1971.

23.4.3.5 Hose, fittings, and quick-connect couplings shall withstand an axial pulling force of at least 1000 N (225 lbf) when at atmospheric pressure and allowable pressure.

23.4.4 Control Devices.

23.4.4.1 The control device shall permit the speed of inflation and deflation of the lifting bag to be gradually and progressively varied under the operator's control.

23.4.4.2 The control device shall be marked or labelled to indicate all positions of buttons or levers and how each position moves the lifting bag.

23.4.4.3 When a manual actuator is moved from any position of actuation to a neutral position, the flow of compressed air shall cease within less than 1.0 seconds.

23.4.4.4 When a manual actuator is released, it shall automatically return to the neutral position within less than 1.0 seconds.

23.4.4.5 Where a system includes two or more control devices connected to the same inlet, the operation of one manual actuator shall only inflate or deflate the lifting bag to which it is connected, regardless of the position of other manual actuators.

23.4.4.6 Operation of one or more control devices in the direction of inflation shall not lead to the deflation of any bag when any of the following happen:

(1) Supply connection to the control device is disconnected.

(2) Supply of compressed air is exhausted or is at pressures less than the pressure in the lifting bag.
(3) There is a sudden hose break of the supply hose to the control device.

23.4.4.7 Where a control device is provided with more than one inlet connection for energizing sources, it shall not be possible for the compressed air from one connection to pass out of another inlet, whether or not a hose is connected to the other inlet.

23.4.4.8 Control devices shall withstand a pressure of two times allowable pressure without leakage.

23.4.4.9 Control devices shall be operated while wearing gloves that are certified as compliant with the glove requirements of NFPA 1971.

23.4.4.10 The allowable inlet pressure of a control device shall be marked on the control device at or near the inlet.

23.4.4.11 When a manual actuator on a control device is actuated in a direction of operation, the lifting bag shall operate only in the direction selected by the operator.

23.4.5 Pressure Indicators.

23.4.5.1 A pressure indication displaying the pressure in the lifting bag shall be provided in a position at which it can be read by the operator while operating the control device.

23.4.5.2 Pressure indicators shall comply with EN 837-1, *Standard Bourdon Tube Pressure Gauges*; EN 837-2, *Pressure Gauges — Part 2: Selection and Installation Recommendations for Pressure Gauges*; EN 837-3, *Pressure Gauges — Diaphragm and Capsule Pressure Gauges — Dimensions, Metrology, Requirements and Testing*; or ASME/ANSI B40.100, *Pressure Gauges and Gauge Attachments*.

23.4.6 Safety Valves.

23.4.6.1 Safety valves shall be provided with means to lock or seal all external adjustments in such a manner so as to prevent unauthorized adjustments of the safety valve.

23.4.6.2 The actuation of a safety valve shall be indicated to the operator by any means such as an audible or visual sign.

23.4.6.3 When the safety valve is fully operating and the supply of air to the control device is maintained constant at the allowable pressure specified for the inlet, the pressure in the lifting bag shall not exceed 1.2 times the allowable pressure for the bag.

23.4.7 Additional/Optional Components. When a manufacturer provides additional load-bearing accessories for its lifting airbag system, the components shall meet or exceed the safety and capacity ratings of the lifting bags.

23.4.8 Regulators. Regulators shall meet standard ISO 2503, *Gas welding equipment — Pressure regulators for gas cylinders used in welding, cutting and allied processes up to 300 bar*; or UL 252, *Standard for Safety Compressed Gas Regulators*.

23.5 Performance Requirements.

23.5.1 The lifting bag system shall be tested for operating temperature range as specified in 23.6.1, and not show signs of failure or leakage.

23.5.2 Hose assemblies shall be tested for pulling force as specified in 23.6.2 and show no signs of leakage.

23.5.3 Hose assemblies shall be tested for proof pressure test as specified in 23.6.3 and show no signs of leakage.

23.5.4 Control devices shall be tested as specified in 23.6.4 to ensure the operation of the lifting bag coincides with the manual operation of the control device.

23.5.5 Control devices shall be tested as specified in 23.6.5 to ensure the flow of air stops within 1.0 second or less when the control device's manual operation is moved to the neutral position.

23.5.6 Control devices shall be tested as specified in 23.6.6 to ensure when the manual actuator of the control device is released it will return to the neutral position within 1.0 second or less.

23.5.7 Control devices shall be tested as specified in 23.6.7 to ensure when a system of two or more control devices connected to the same inlet(s) is present, the operation of one manual actuator only inflates or deflates the lifting bag to which it is connected, regardless of the position of the other manual actuators.

23.5.8 Control devices shall be tested as specified in 23.6.8 to ensure that the operation of one or more control devices in inflation mode does not lead to the deflation of any bag when the supply connection to the control device is disconnected, the supply of compressed air is no longer present or at a pressure less than the pressure in the lifting bag, or there is a sudden loss of compressed air due to a hose failure.

23.5.9 Control devices shall be tested as specified in 23.6.9 to ensure compressed air from one connection cannot pass out of another inlet, with or without a hose connected, when a control device is provided with more than one inlet connection.

23.5.10 Control devices shall be tested as specified in 23.6.10 to ensure that the device shows no signs of leakage at overpressure of two times the allowable pressure.

23.5.11 Safety valves shall be tested as specified in 23.6.11 to ensure their actuation results in either an audible or visual method of notifying the operator the valves have operated.

23.5.12 Safety valves shall be tested as specified in 23.6.11.

23.5.13 Lifting bags shall be tested as specified in 23.6.12 for overpressure.

23.5.14 Resistance Against Penetration Test.

23.5.14.1 Lifting bags shall be tested as specified in 23.6.13 for resistance against penetration.

23.5.14.2 A manufacturer shall apply either of the following requirements, or both:

(1) The following requirements are applicable to samples of materials:
    (a) The material used in the construction of a lifting bag shall resist penetration as tested per 23.6.13.
    (b) Samples presented for testing shall be taken from standard production bags.
    (c) All materials forming the pressure-containing bag, including any additional layers forming the bearing or side wall surfaces, shall be tested.
    (d) Where the construction of the bag varies in material thickness, number of layers, or reinforcing fibers or

wires, samples that are representative of all variations shall be tested.

(2) The following requirements are applicable to complete lifting bags:

(a) The material used in the construction of the lifting bag shall resist penetration at the load-bearing surfaces and all other areas directly contacting the load while the lifting bag is inflated as per 23.6.13.

(b) Where the construction of the upper and lower load-bearing surfaces of a bag differs, each surface shall achieve the required standard.

23.5.15 Lifting bags shall be tested as specified in 23.6.14 to ensure the speed of descent is not more than 25 mm/sec (1 in./sec) when the lifting bag is supporting a load at allowable pressure.

23.5.16 Lifting bags shall be tested as specified in 23.6.15 to ensure the connector incorporated into the lifting bag can withstand an axial pulling force of 1000 N (225 lbf) for 1 minute and show no signs of leakage.

23.5.17 Lifting bags shall be tested to ensure label legibility as specified in 23.6.16.

23.5.18 Lifting bags shall be tested as specified in 23.6.17 to ensure the lifting capacity of the bag.

23.6 Testing.

23.6.1 Lifting Bag Operating Temperature Test.

23.6.1.1 Temperature.

23.6.1.1.1 The lifting bag, regulator, control device, and hose assembly shall be stored in a temperature-conditioning chamber of −20°C ± 2°C (−4°F ± 4°F) for a minimum of 5 hours.

23.6.1.1.2 The 5-hour storage time shall begin when the temperature-conditioning chamber has stabilized at −20 ± 2°C (−4°F ± 4°F).

23.6.1.2 The lifting bag, regulator, control device, and hose assembly shall be removed from the temperature-conditioning chamber after being subjected to at least 5 hours at the conditioning temperature.

23.6.1.2.1 Within 3 minutes after removal from the temperature-conditioning chamber, the devices shall be assembled, connected to the air source, and pressurized to the allowable pressure.

23.6.1.2.2 The system shall remain pressurized for 1 minute.

23.6.1.3 The lifting bag, regulator, control device, and hose assembly shall be observed for defects and leaks during the 1-minute pressurization.

23.6.1.4 Second Test.

23.6.1.4.1 The same test specimens, with the lifting bag deflated, shall then be stored in a temperature-conditioning chamber of 55°C ± 2°C (131°F ± 4°F) for a minimum of 5 hours.

23.6.1.4.2 The 5-hour storage time shall begin when the temperature-conditioning chamber has stabilized at 55°C ± 2°C (131°F ± 4°F).

23.6.1.5 The lifting bag, regulator, control device, and hose assembly shall be removed from the temperature-conditioning chamber after being subjected to at least 5 hours at the conditioning temperature.

23.6.1.5.1 Within 3 minutes after removal from the temperature-conditioning chamber, the devices shall be assembled, connected to the air source, and pressurized to the allowable pressure.

23.6.1.5.2 The system shall remain pressurized for 1 minute.

23.6.1.6 The lifting bag, regulator, control device, and hose assembly shall be observed for defects and leaks during the 1-minute pressurization.

23.6.2 Hose Assembly Pulling Force Test.

23.6.2.1 An axial pulling force of a minimum of 1000 N (225 lbf) shall be applied to the hose assembly for 1 minute with the hose pressurized to allowable pressure.

23.6.2.2 Leakage of the hose assembly shall constitute failure.

23.6.3 Hose Assembly Proof Pressure Test.

23.6.3.1 A sample representative hose assembly shall be attached to an air or a water supply capable of supplying four times the operating pressure.

23.6.3.2 A pressure gauge shall be attached to the end of the hose assembly.

23.6.3.3 The hose assembly shall be pressurized to four times the allowable pressure.

23.6.3.4 Leakage of the hose assembly shall constitute failure.

23.6.4 Control Device Dedicated Operation Test.

23.6.4.1 The control device(s) shall be assembled into a system and connected to a lifting bag.

23.6.4.2 Inflation.

23.6.4.2.1 Each control device shall be operated in the inflate mode.

23.6.4.2.2 It shall be verified that lifting bags connected control devices are set to operate in the inflate direction.

23.6.4.3 Deflation.

23.6.4.3.1 Each control device shall be operated in the deflate mode.

23.6.4.3.2 It shall be verified that lifting bags connected to control devices are set to operate in the deflate direction.

23.6.4.4 A control device that does not operate its associated lifting bag in each intended mode of operation shall constitute failure.

23.6.5 Control Device Neutral Position Flow of Air Test.

23.6.5.1 The control device shall be assembled into the system with a lifting bag specimen.

23.6.5.2 Inflation.

23.6.5.2.1 The bag shall be inflated.

23.6.5.2.2 During inflation, the manual actuator of the control device shall be released.

23.6.5.3 Neutral Position.

23.6.5.3.1 Once the manual actuator returns to the neutral position air flow shall cease in 1.0 second or less.

23.6.5.3.2 Air flow continuing after 1.0 second shall constitute failure.

23.6.5.4 The test shall be repeated with the lifting bag being deflated.

23.6.6 Control Device Neutral Position Test.

23.6.6.1 The control device shall be assembled into the system with a lifting bag specimen.

23.6.6.2 Inflation.

23.6.6.2.1 The bag shall be inflated.

23.6.6.2.2 During inflation, the manual actuator of the control device shall be released.

23.6.6.3 Neutral Position.

23.6.6.3.1 The manual actuator shall return to the neutral position in 1.0 second or less.

23.6.6.3.2 Not returning in 1.0 second or less shall constitute failure.

23.6.7 Control Device Dedicated Controller Test.

23.6.7.1 Each control device shall be assembled into a system and connected to a separate lifting bag.

23.6.7.2 Inflation.

23.6.7.2.1 Each control device shall be operated independently in the inflate mode.

23.6.7.2.2 It shall be verified that lifting bags connected to control devices are set to operate in the inflate direction.

23.6.7.3 Deflation.

23.6.7.3.1 Each control device shall be operated independently in the deflate mode.

23.6.7.3.2 It shall be verified that lifting bags connected to control devices are set to operate in the deflate direction.

23.6.7.4 A control device that does not operate its associated lifting bag in the intended mode of operation shall constitute failure.

23.6.8 Control Device Nonaccidental Deflation Test.

23.6.8.1 The control device(s) shall be connected to a hose assembly with a gauge attached.

23.6.8.2 The hose assembly shall be pressurized to the allowable pressure.

23.6.8.3 The inlet hose to the control device(s) shall be depressurized to atmospheric pressure.

23.6.8.4 The inlet hose to the control device shall be disconnected from the control device.

23.6.8.5 A minimum of a 0.5 m (1.5 ft) hose assembly with the noncontrol device end open to the atmosphere shall be connected to the control device's inlet while the actuators are held in the inflation position.

23.6.8.6 Any loss of pressure from the controller shall constitute failure.

23.6.9 Control Device Single Inlet Air Flow Test.

23.6.9.1 For control devices with more than one inlet, a supply hose shall be connected to the inlet.

23.6.9.2 A hose open to atmosphere shall be connected to the each additional inlet.

23.6.9.3 The control device shall be pressurized to allowable pressure.

23.6.9.4 Air flowing from the open hose of any additional inlet shall constitute failure.

23.6.10 Control Device Overpressure Test.

23.6.10.1 Safety devices shall be allowed to be overridden or removed from the control device.

23.6.10.2 Pressure indicators shall be allowed to be removed from the control device and their connections blocked off.

23.6.10.3 The control device shall be connected to either an air or a hydraulic supply capable of supplying twice the allowable pressure.

23.6.10.4 A hose assembly with a pressure test gauge shall be attached to an outlet of the control device.

23.6.10.5 The control device shall be pressurized to twice the allowable pressure by pressurizing the outlet hose on the control device.

23.6.10.6 Leakage to the control device or leakage of the control device shall constitute failure.

23.6.11 Control Safety Valve Test.

23.6.11.1 A hose assembly, with a connected external pressure gauge, shall be connected to the outlet side of the control device.

23.6.11.2 A minimum test pressure of 125 percent of the allowable pressure specified for the control device shall be applied to the inlet of the control device.

23.6.11.3 The actuator shall be activated with respect to the outlet with the hose assembly and held in the open position to cause the safety valve to activate.

23.6.11.4 Once the safety valve actuates, an audible or visual notification shall be given.

23.6.11.5 The maximum pressure of the pressure gauge on the outlet side shall be recorded.

23.6.11.6 The test for each control device outlet shall be repeated.

23.6.11.7 The pressure in the outlet hose exceeding 120 percent of allowable pressure or the safety valve not resetting itself shall constitute failure.

23.6.11.8 Failure to produce an audible or visual indication shall constitute failure.

23.6.12 Lifting Bag Overpressure Test.

23.6.12.1 For the lifting bag overpressure test, the lifting bag shall be permitted to be restrained at the maximum lifting bag height or unrestrained as decided by the manufacturer based

on the type of bag where low pressure [<1 bar (<14.5 psi)] constitutes restrained, and high pressure [>1 bar (>14.5 psi)] constitutes unrestrained.

23.6.12.2 If the lifting bag is to be tested restrained, the restraining apparatus shall be set to the maximum lifting height of the bag.

23.6.12.3 Any integral safety or relief valves in the bag shall be blocked off.

23.6.12.4 The lifting bag shall be pressurized to the required test pressure in 23.4.2.1 while measuring the pressure using an external pressure gauge or pressure transducer with a digital readout.

23.6.12.5 The test pressure shall be applied for a minimum of 15 seconds.

23.6.12.6 Any leakage or visual structural damage of the lifting bag failure shall constitute failure of the test.

23.6.13 Lifting Bag Penetration Test.

23.6.13.1 The requirements in 23.6.13.1.1 through 23.6.13.1.13 shall be applicable to samples of materials *(see Figure 23.6.13.1)*.

23.6.13.1.1 The material used in the construction of a lifting bag shall resist penetration.

23.6.13.1.2 Samples presented for testing shall be taken from standard production bags.

23.6.13.1.3 All materials forming the lifting bag, including any additional layers forming the bearing or side wall surfaces, shall be tested.

23.6.13.1.4 Where the construction of the bag varies in material thickness, number of layers, reinforcing fibers, or wires, samples representative of all variations shall be tested.

23.6.13.1.5 The samples of the finished materials or lifting bags to be tested shall be no more than 90 days old from the date of manufacture.

23.6.13.1.5.1 The samples or lifting bags shall be conditioned at 21°C, ± 2°C (70°F, ± 4°F) for a minimum of 3 hours prior to the tests.

23.6.13.1.5.2 A new pin shall be used for each test.

23.6.13.1.5.3 The sample shall be clamped to the test frame and sealed to the top of the cylinder *(see Figure 23.6.13.1.5.3)*.

23.6.13.1.5.4 An inlet/exhaust pipe shall be fitted with a valve and pressure gauge to measure the internal pressure of the cylinder.

23.6.13.1.6 The steel test pin shall be a minimum of 20 mm (0.79 in.) long with a diameter of 6 mm (0.24 in.) and the end having a radius of not more than 0.1 mm (0.004 in.) extending far enough below its securing device to ensure that only the pin comes into contact with the sample during the test *(see Figure 23.6.13.1.6)*.

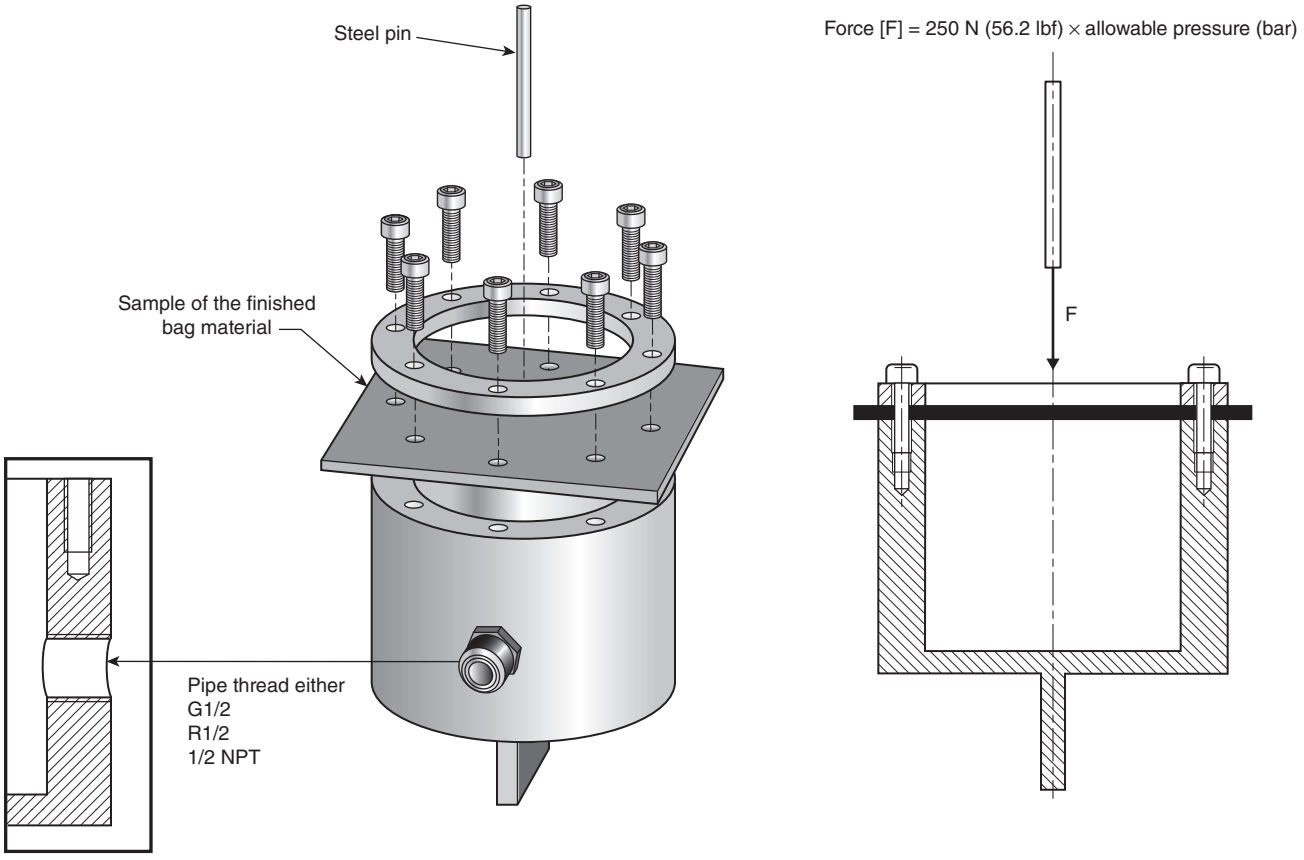
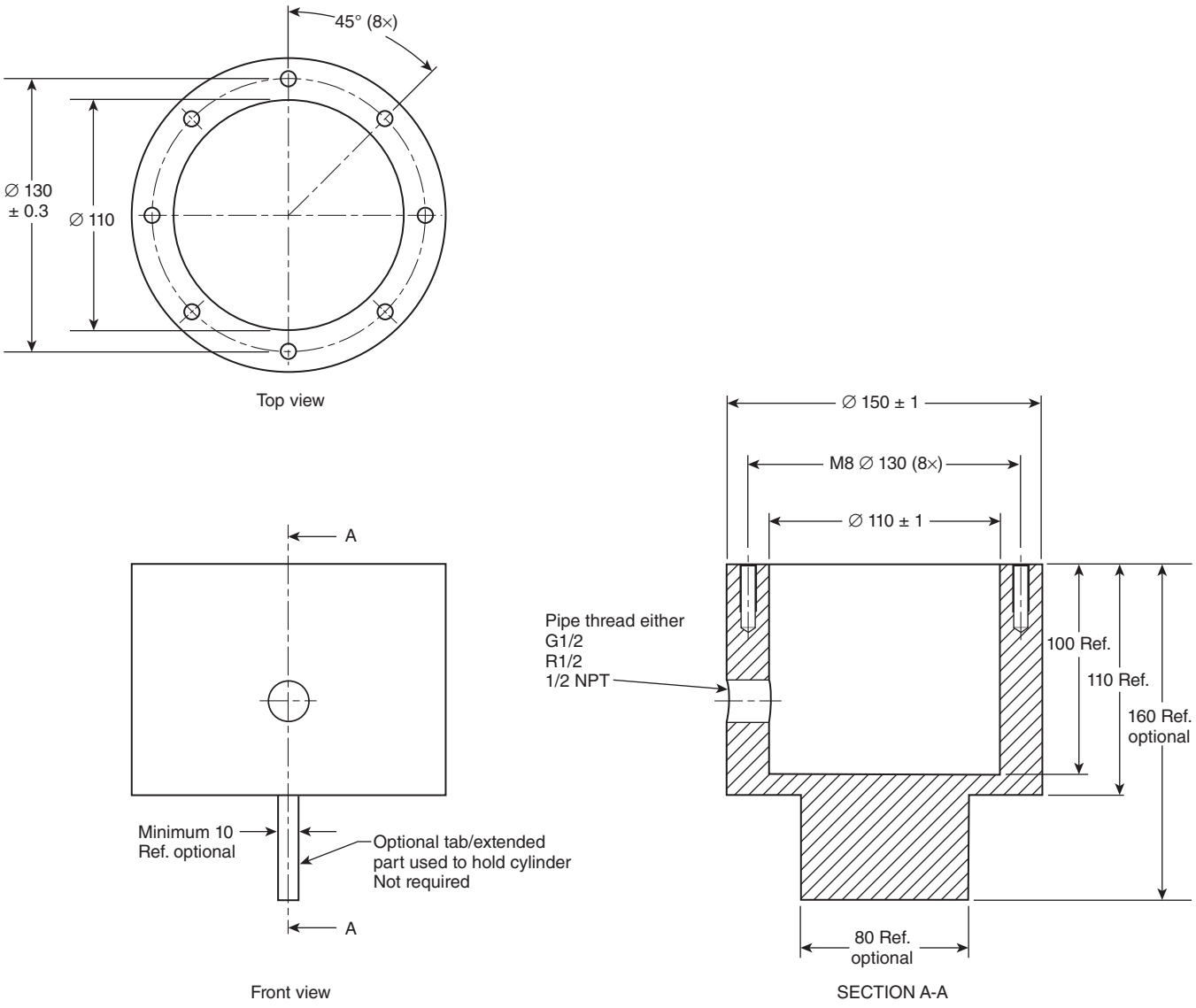


FIGURE 23.6.13.1 Lifting Bag Penetration Overview.



Dimensions in mm
For U.S. units, 25.4 mm = 1 in.

FIGURE 23.6.13.1.5.3 Lifting Bag Penetrator Test Cylinder.

23.6.13.1.7 The pin shall be positioned centrally over the cylinder *(see Figure 23.6.13.1.7)*.

23.6.13.1.8 The sample shall be secured over the cylinder ensuring that the thinnest section of the material is below the pin.

23.6.13.1.9 Pressurization.

23.6.13.1.9.1 The cylinder shall be pressurized to the allowable pressure for the bag type for which the sample is designated.

23.6.13.1.9.2 The flange seal shall be checked for leaks.

23.6.13.1.10 Pressure Release.

23.6.13.1.10.1 The pressure shall be released.

23.6.13.1.10.2 The cylinder shall be vented to atmosphere to ensure there is no increase in pressure during the next step.

23.6.13.1.11 The pin shall be lowered at a speed of 100 mm/min (3.94 in./min), at a force of 250 N (56.2 lbf) × AP (allowable pressure in units bar) but not less than 1000 N (225 lbf).

23.6.13.1.12 Repressurization.

23.6.13.1.12.1 The pin shall be withdrawn.

23.6.13.1.12.2 The cylinder shall be pressurized as in 23.6.13.1.9 and inspected for leakage.

23.6.13.1.13 Leakage through the material in 23.6.13.1.12.1 shall constitute failure.