# UL 2443

## STANDARD FOR SAFETY

Flexible Sprinkler Hose with Fittings for Fire Protection Service

UL Standard for Safety for Flexible Sprinkler Hose with Fittings for Fire Protection Service, UL 2443

Fourth Edition, Dated September 7, 2023

***Summary of Topics***

***This new edition of ANSI/UL 2443, dated September 7, 2023, includes the following changes in requirements:***

***– Editorial changes; Section 4***

***– Maximum K-factor of Sprinkler Intended to be Attached to a Flexible Hose Based Upon the Inside Diameter of the Hose; 6.4 and Table 6.1***

***– New Method for Determining Flexible Hose Pressure Loss and Referencing the Pressure Losses in the Manufacturer's Instructions; Section 12***

***– Update to Marking Requirements; 24.1, 24.3, and 25.1***

***– Electronic Installation Instructions; 25.1***

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated June 30, 2023.

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# UL 2443

## Standard for Flexible Sprinkler Hose with Fittings for Fire Protection Service

First Edition – November, 2004
Second Edition – May, 2010
Third Edition – August, 2015

**Fourth Edition**

**September 7, 2023**

This ANSI/UL Standard for Safety consists of the Fourth Edition.

The most recent designation of ANSI/UL 2443 as an American National Standard (ANSI) occurred on September 7, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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## CONTENTS

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## INTRODUCTION

### 1 Scope

1.1 This Standard covers flexible sprinkler hose with fittings intended for direct connection to fire sprinklers in installations requiring a flexible attachment to the sprinkler system piping such as clean rooms, suspended ceilings, and exhaust ducts.

1.2 The products covered by this Standard are intended for use in sprinkler systems installed in accordance with the Standard for Installation of Sprinkler Systems, NFPA 13; Standard for the Installation of Sprinkler Systems in Residential Occupancies Up to Four Stories in Height, NFPA 13R; and Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes, NFPA 13D.

### 2 Components

2.1 Except as indicated in 2.2, a component of a product covered by this Standard shall comply with the requirements for that component.

2.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this Standard, or

b) Is superseded by a requirement in this Standard.

2.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

### 3 Units of Measurement

3.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

### 4 Referenced Publications

4.1 Any undated reference to a code or standard appearing in the requirements of this Standard shall be interpreted as referring to the latest edition of that code or standard.

4.2 The following publications are referenced in this Standard:

ASME B1.20.1, *Pipe Threads, General Purpose (Inch)*

ASTM A53/A53M, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*

ASTM A653/A653M, *Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process*

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

ASTM B568, *Standard Test Method for Measurement of Coating Thickness by X-Ray Spectrometry*

ASTM C635/C635M, *Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings*

ASTM C636/C636M, *Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels*

AWWA C606, *Grooved and Shouldered Joints*

NFPA 13, *Installation of Sprinkler Systems*

NFPA 13D, *Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*

NFPA 13R, *Installation of Sprinkler Systems in Low-Rise Residential Occupancies*

UL 157, *Gaskets and Seals*

UL 213, *Rubber Gasketed Fittings for Fire Protection Service*

UL 969, *Marking and Labeling Systems*

UL 1821, *Thermoplastic Sprinkler Pipe and Fittings for Fire Protection Service*

## 5 Glossary

5.1 For the purpose of this Standard the following definitions apply:

5.2 BEND – A 90-degree change in direction of the flexible sprinkler hose.

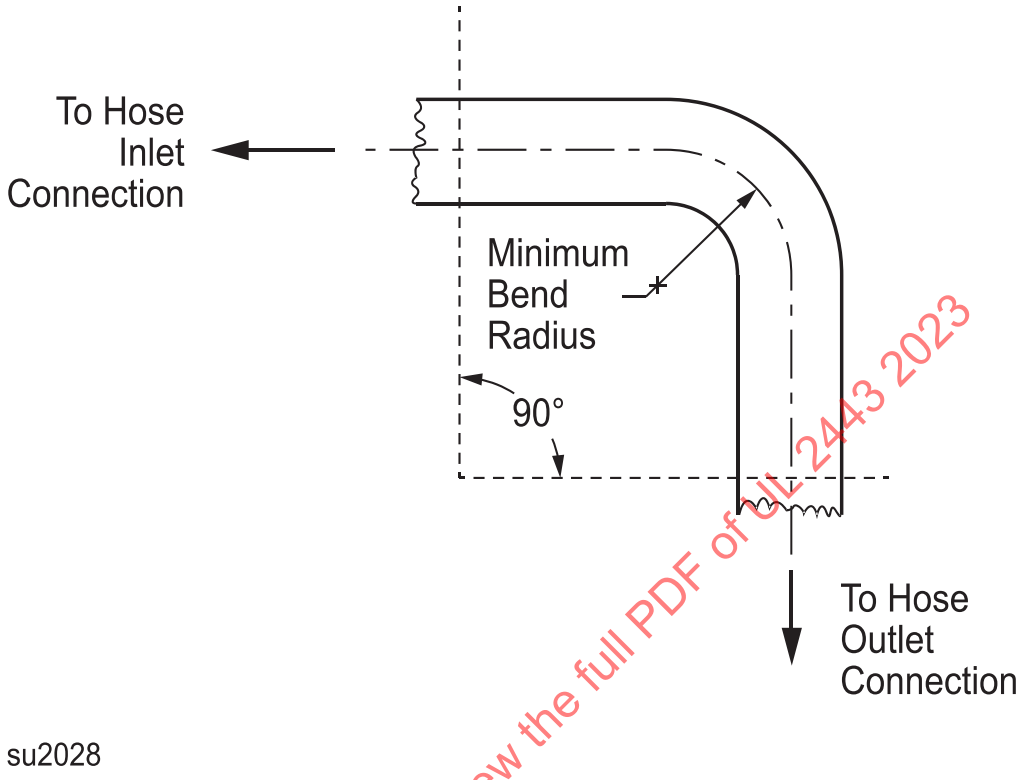
5.3 FLEXIBLE HOSE WITH FITTINGS HAVING HIGH FLEXIBILITY – This type of hose with fittings is intended to be used in applications where frequent movement between the two ends of the hose is expected after installation.

5.4 FLEXIBLE HOSE WITH FITTINGS HAVING LIMITED FLEXIBILITY – This type of hose with fittings is intended to be used in applications where little or no movement between the two ends is expected after installation.

5.5 MINIMUM BEND RADIUS – The least distance permitted by the manufacturer as measured from the focal point to the centerline of the hose. See Figure 5.1.

**Figure 5.1**

**Minimum Bend Radius**






5.6 PROPRIETARY GROOVE– Dimensions of a grooved end that differ by dimension or tolerance from those specified in AWWA C606. These proprietary grooves are intended for use with specific rubber gasketed fittings for which the combination of the groove and fitting has demonstrated compliance in UL 213.

## CONSTRUCTION

### 6 General

6.1 Flexible sprinkler hose with threaded end fittings shall be constructed of metallic pressure retaining components and have a rated pressure of 175 psig (1.21 Mpa) or higher.

*Exception: The end fittings of flexible sprinkler hose are permitted to be constructed of thermoplastic material complying with the applicable requirements of UL 1821 and when specified in the installation instructions to be connected directly to thermoplastic sprinkler piping.*

6.2 The inlet shall have a nominal 1-inch size or larger male or female NPT pipe threads in accordance with ASME B1.20.1 or other suitable means of connection such as a grooved fitting in at least a 1-inch size. The outlet shall have 1/2, 3/4 or 1-inch female NPT pipe threads.

*Exception: Flexible hose with threaded fitting ends intended for use in installations where fittings incorporate pipe threads other than NPT type threads shall be permitted to be provided with pipe threads complying with a national pipe thread standard compatible with those fittings.*

6.3 Grooved inlet connections shall either comply with the groove dimensions specified in AWWA C606 or have proprietary grooves.

6.4 The flexible hose shall be provided with the fittings attached and secured to the hose. The largest nominal sprinkler K-factor permitted to be referenced for use with a hose assembly shall be in accordance with Table 6.1. In no case shall the hose or fittings have an inside diameter less than 0.75 inch (19 mm).

*Exception: Outlet fittings with 1/2-inch female pipe threads are permitted to have an inside diameter of not less than 0.622 inches (15.8 mm), in accordance with the inside diameter of a 1/2-inch Schedule 40 pipe as specified in ASTM A53/A53M.*

**Table 6.1**
**Minimum Hose Diameter for Sprinkler K-factor**

| Nominal K-factor of attached sprinkler, gpm/(psi)$^{1/2}$(L/min/(bar)$^{1/2}$) | Minimum inside diameter of hose, inches (mm) |
|---|---|
| ≤5.6 (80) | 0.75 (19.0) |
| 8.0 (115) | 0.75 (19.0) |
| 11.2 (160) | 0.90 22.9) |
| 14.0 (200) | 1.0 (25.2) |
| >14.0 (200) | See Note |
| NOTE – For sprinklers having a nominal K-factor greater than 14.0 (200), the inside diameter of the hose shall not create a flow velocity within the hose greater than 15 ft/sec (4.6 m/sec) when a flowing 7 psi (48 kPa) inlet pressure of the sprinkler. For example, the flow velocity through a hose for a sprinkler having a nominal K-factor of 16.8 is to be calculated based upon a flow of 44.5 gpm (168 lpm). | |



6.5 The maximum length of a flexible sprinkler hose with fitting shall be 6 feet (1.8 m).

6.6 A flexible sprinkler hose shall be constructed to allow not less than the number of bends as specified in Table 6.2.

**Table 6.2**
**Number of Bends**

| Flexible sprinkler hose length | Number of bends |
|---|---|
| 2 feet (610 mm) and less | 1 |
| Over 2 feet (610 mm) up to 3 ft (914 mm) | 2 |
| 3 feet (914 mm) and greater | 3 |

6.7 Sprinklers shall be permitted to be installed into the end fitting on a flexible hose prior to shipment if all of the following conditions are met:

a) Each flexible hose and sprinkler assembly shall be pressure tested in accordance with Section 23 prior to shipment.

b) The sprinkler shall be installed in accordance with the sprinkler manufacturer's installation instructions.

c) Protection, such as a plastic cover, shall be provided for the entire sprinkler, including the deflector, heat responsive element and escutcheon (if provided), to minimize the potential for damage during shipment, storage, and installation.

The installation instructions include a statement indicating that the protection shall remain in place prior to and during installation, and shall be removed from the sprinkler prior to the time when the sprinkler system is placed into service. See 23.2(p).

## 7 Materials

7.1 A pressure retaining part constructed of ferrous metal (not including stainless steel) shall have a wall thickness of not less than 0.109 inch (2.76 mm).

7.2 Flexible hose and braiding (if provided) shall be constructed of a material having resistance to corrosion equivalent to or exceeding that of bronze or Series 300 stainless steel.

7.3 Loading carrying anchoring components shall be made of metallic materials, or non-metallic materials evaluated to provide acceptable performance for the application.

7.4 Anchoring components made of ferrous metal having a thickness less than 0.119 inch (3.0 mm) shall be protected by a coating described in 7.5, or comply with the Salt Spray Corrosion Test, Section 13.

7.5 With reference to 7.4, the following coatings meet this requirement:

a) A zinc coating having a minimum thickness of 0.0005 inch (0.0127 mm) on all outside surfaces and 0.0003 inch (0.0076 mm) on all inside surfaces. The thickness of the coating is to be established by the Metallic Coating Thickness Test, Section 22.

b) A hot-dipped mill galvanized sheet steel referenced by the manufacturer as conforming with the coating designation G90 in Table I of ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM Designation. The weight of the zinc coating is to be determined by any equivalent method; however, in case of question, the weight of the coating shall be established in accordance with the test method of ASTM A90/A90M. The edges of a stamping complying with this requirement are not required to be plated.

# PERFORMANCE

## 8 Change of Length, Leakage and Hydrostatic Strength Tests

8.1 When tested as specified in 8.2 and 8.3, flexible hose with fittings shall show no:

a) Change in length of more than 1 percent of the hose length during and after pressurization to 1.5 times the rated working pressure;

b) Signs of leakage at twice the rated working pressure; or

c) Rupture at four times the rated working pressure.

8.2 Two samples each of the minimum and maximum lengths are to be subjected to this test. Each test sample is to be fitted with pipe plugs, filled with water in such a manner as to exclude all air, and connected to a hydrostatic pressure source. The sample hose inlet is to be secured and the hose length is to be measured in the straight condition with the hose unpressurized. A deflectometer or similar device is to be positioned to continuously measure the movement of the sprinkler outlet. The initial position of the sprinkler outlet is to be measured unpressurized and recorded. The inlet pressure is then to be gradually

increased to 20 psig (138 kPa) and the position of the sprinkler outlet is to be measured and recorded. The inlet pressure is then to be gradually increased to 1.5 times the rated working pressure and held for 1 minute. After 1 minute, the length of the hose is to be measured again and compared to the measurement taken at 20 psig (138 kPa) to determine compliance with 8.1 (a during pressurization. The pressure is then to be decreased to 0 psig (0 kPa) and the position of the sprinkler outlet is to be compared to the initial recorded measurement of the unpressurized sample to determine compliance with 8.1 a) after being pressurized to 1.5 times the rated working pressure.

8.3 Subsequent to the testing in 8.2, the pressure is to be gradually increased to two times the rated pressure and held for 1 minute. Observations are to be made for leakage. The pressure is then to be gradually increased to four times the rated working pressure of the sample, held for 5 minutes and observations made for rupture of the test samples.

## 9 Mechanical Strength Test

9.1 A flexible sprinkler hose with fittings installed in its intended position using the anchoring components referenced in the installation instructions shall withstand a torque of 60 pound-feet (81 N·m) applied to the outlet without permanent movement, deformation, or fracture of the fitting outlet.

9.2 The anchoring components are to be secured in accordance with the manufacturer's installation instructions with the outlet located 3 inch (±0.125 inch) from one of the ends of the anchored support bar. This distance is to be from the centerline of the fitting outlet to the inside edge of the structure to which the end bracket is attached. A 60 pound-foot (81 N m) torque is then to be applied at the outlet in a direction to tighten the sprinkler for 10 seconds. If the design of the anchoring system is asymmetrical and is not preassembled at the factory, separate samples are to be tested so that the orientations considered to be most challenging are evaluated for mechanical strength.

9.3 Following the application of the torque, the sample is to be visually examined for permanent movement, deformation or fracture of the fitting outlet.

## 10 High Temperature Exposure Test

10.1 When tested as specified in 10.2, a flexible sprinkler hose with fittings constructed using elastomeric or polymeric seals shall show no evidence of leakage or rupture.

10.2 Two samples are to be prepared and subjected to a hydrostatic pressure of twice the rated working pressure in accordance with 8.2. The samples are then to be allowed to dry and then exposed to an ambient temperature in accordance with Table 10.1 for 90 days. Following this exposure, the samples are to be individually subjected to a hydrostatic pressure of twice the rated working pressure for 1 minute.



**Table 10.1**
**Test Temperatures**

| Maximum intended ambient temperature rating | | Test temperature | |
|---|---|---|---|
| °F | (°C) | °F | (°C) |
| 150 | (66) | 175 | (79) |
| 225 | (107) | 250 | (121) |
| 300 | (149) | 325 | (163) |

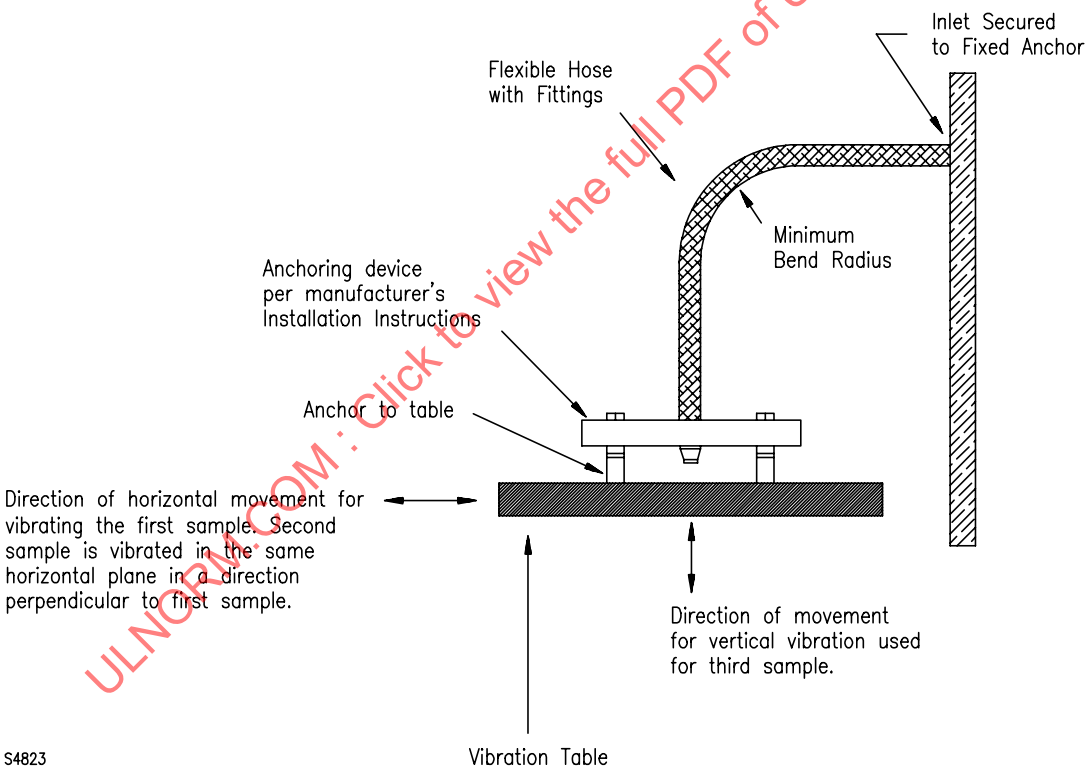
## 11 Vibration Test

11.1 When tested as specified in 11.2 – 11.4, a flexible sprinkler hose with fittings shall show no evidence of leakage, rupture, or movement of the outlet fitting affecting the performance of the flexible hose assembly.

11.2 Three samples of a representative hose length are to be subjected to this test, except that a fourth sample is required to be tested if the flexible hose with fitting is intended to be installed in vertical orientation with no bends. The outlet fitting is to be installed in its intended position using the anchoring components referenced in the installation instructions and the anchoring device is then to be rigidly attached to the vibration table with the outlet fitting in a vertical plane. Except for the test on the fourth sample, each hose is to be bent in a 90 degree angle using its minimum bend radius at a location near the middle of the sample. The inlet end of each test sample shall be securely fixed in a horizontal plane. Reference Figure 11.1.

**Figure 11.1**

**Vibration Test Arrangement for Flexible Hoses Bent to the Minimum Bend Radius**






11.3 Each sample is to be hydrostatically pressurized to the rated working pressure. One sample is to be tested with the sample vibrated horizontally using a 0.02-inch (0.51-mm) amplitude at a varying frequency ranging from 18 to 37 Hz for a period of 5 hours. The cycle period is to be 25 ±5 seconds. If one or more resonant points are clearly detectable, the assemblies are to be vibrated at that frequency or frequencies for periods of the remaining 25 hours of the test proportionate to the number of resonant frequencies. If no resonant frequency is detected, then tests are to be conducted at the amplitudes, frequencies, and time periods noted in Table 11.1. Amplitude is the maximum displacement of sinusoidal motion from position of rest or one-half of the total table displacement. The second sample is to be vibrated in the same manner, but with the movement in a horizontal direction perpendicular to the first sample. The third sample is to be vibrated in the same manner, but with the movement in a vertical direction. The fourth sample, if required

as described in 11.2, is to be vibrated in the same manner with the movement in the vertical direction with the sample installed in the vertically straight orientation.

**Table 11.1**
**Amplitude of Vibration**

| Amplitude | | Total displacement | | | |
|---|---|---|---|---|---|
| Inch | (mm) | Inch | (mm) | Frequency, Hz | Time Hours |
| 0.010 ±0.001 | (0.25 ±0.025) | 0.020 ±0.002 | (0.51 ±0.051) | 28 ±1 | 5 |
| 0.020 ±0.002 | (0.51 ±0.051) | 0.040 ±0.004 | (1.02 ± 0.102) | 28 ±1 | 5 |
| 0.075 ±0.0075 | (1.90 ±0.0019) | 0.150 ±0.015 | (3.81 ±0.381) | 28 ±1 | 5 |
| 0.020 ±0.002 | (0.51 ±0.051) | 0.040 ±0.004 | (1.02 ±0.102) | 18 – 37 (variable) | 5 |
| 0.035 ±0.0035 | (0.89 ±0.0089) | 0.070 ±0.007 | (1.78 ±0.178) | 18 – 37 (variable) | 5 |

11.4 During and after being subjected to the required vibration, the samples are to be examined for signs of leakage, rupture, or movement of the outlet fitting affecting the performance of the flexible hose assembly. Each sample is then to be subjected to two times the rated pressure described in the Change of Length, Leakage and Hydrostatic Strength Tests, Section 8, and observations made for leakage or rupture.

## 12 Equivalent Length Determination

12.1 When tested as described in 12.4 and 12.6, the pressure loss of flexible hose with fittings, expressed in equivalent length of Schedule 40 pipe having a Hazen-Williams coefficient of friction of 120 in the same nominal size as the inlet connection, shall not be more than the equivalent length values published in the installation instructions.

12.2 The manufacturer's installation instructions [see 25.1(d)] shall indicate that the equivalent length value used a water system's hydraulic calculation shall be based upon the maximum number of bends and minimum bending radius.

12.3 The manufacturer's installation instructions shall be permitted to reference an equivalent length value for a fewer number of bends with the minimum bending radius in the hydraulic calculation where all of the following conditions are met:

a) The fewest number of bends referenced for use in the system's hydraulic calculation is not less than those specified in Table 6.2;

b) The flexible hose assembly is tested to determine the equivalent length with the minimum or fewer number of bends and minimum bending radius to be referenced for use in a system's hydraulic calculation;

c) Compliance with the Pressure Cycling Test, Section 18, and the High Pressure Flow Test, Section 20, is determined with maximum number of bends; and

d) The equivalent value for each additional bend at the minimum bending radius between the minimum and maximum number of bends is determined using is the following formula:

$$\text{Equivalent Length for Each Additional Bend} = \left(\frac{EL_{max} - EL_{hc}}{Bend_{max} - Bend_{hc}}\right) \text{(always rounded up to the next whole number)}$$

$EL_{max}$ = Equivalent length of hose assembly with the maximum number of bends at the minimum bending radius, ft (m)

$EL_{hc}$ = Equivalent length of hose assembly with the fewest tested number of bends at the minimum bending radius, ft (m)

$Bend_{max}$ = Maximum number of bends specified for the hose assembly

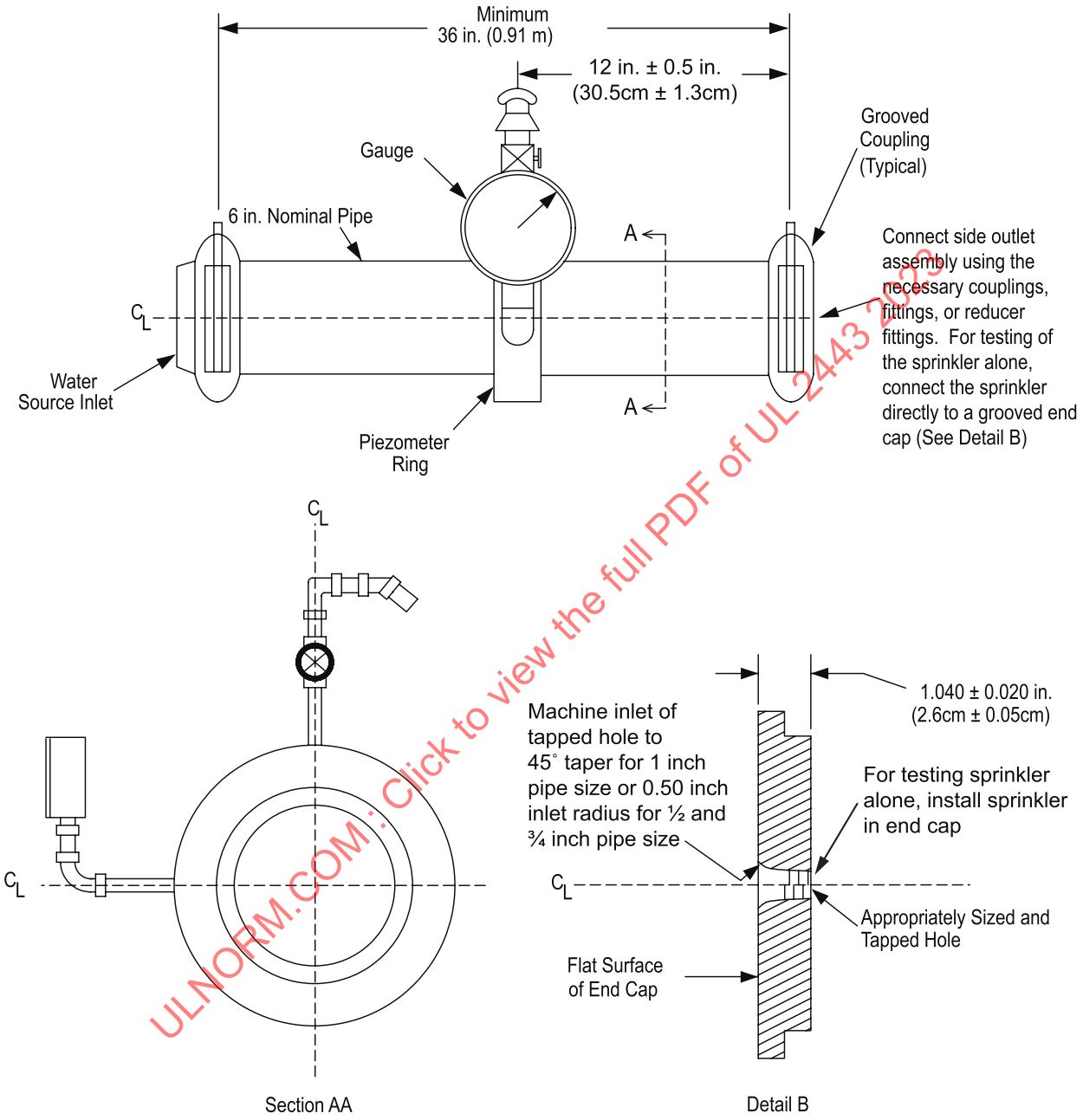
$Bend_{hc}$ = Hose assembly with fewest tested number of bends

12.4 A sample of each length shall be tested with the maximum number of minimum radii bends referenced in the installation instructions and the minimum (or fewer) number of bends with the minimum radii, if equivalent length values are to be referenced for a fewer number of bends in the installation instructions as specified in 12.3.

12.5 The pressure loss through the hose and fittings, expressed in equivalent length of Schedule 40 pipe described in 12.1, shall be determined using a discharge coefficient apparatus. See Figure 12.1 for an example of this test apparatus. The equivalent length value is to be calculated from the data generated by determining the K-factor of the sprinkler directly connected to the test apparatus, and the flexible hose and fittings directly connected to the test apparatus with the sprinkler attached to the hose outlet fitting.

**Figure 12.1**

**Typical Discharge Coefficient Test Apparatus**

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Note: All dimensions are nominal size except as noted

12.6 The maximum nominal sprinkler K-factor intended for use with the flexible hose and fittings shall be used for testing. The average K-factor for sprinkler sample shall be determined by directly connecting the sprinkler to the discharge coefficient test apparatus. To determine the average K-factor, a water pressure in the discharge coefficient test apparatus is to be initially set at 20 psig (138 kPa) and then increased in 20 psig (138 kPa) increments up to 100 psig (690 kPa) and the flow rate is to be recorded at each pressure. Subsequently, the same sample sprinkler is to be installed onto the flexible sprinkler hose and fitting assembly with the assembly directly connected to the test apparatus to determine the average K-factor of the assembly at the same pressures. The average equivalent value for the flexible hose fitting shall be calculated using the following formula:

$$EL = \left(\left(Qn^2 / Kn^2\right) - \left(Qn^2 / Ks^2\right)\right) / Fn$$

where:

*EL* = Average equivalent length of 1 inch schedule 40 pipe using Hazen-Williams coefficient of 120 for tested flows, feet (m)

*Qn* = Individual test flow value for the flexible hose with sprinkler attached, gpm (lpm)

*Kn* = K-factor for flexible hose with sprinkler attached for each individual tested flow, gpm/$(psi)_{1/2}$ ((lpm/$(kPa)_{1/2}$)

*Ks* = Average measured K-factor of sprinkler only that is attached to hose, gpm/$(psi)_{1/2}$ ((lpm/$(kPa)_{1/2}$)

*Fn* = Friction loss per foot of 1 inch schedule 40 pipe using Hazen-Williams coefficient of 120 for each individual tested flow, psi/ft (kPa/m)

The K-factor is calculated at each pressure using the following formula:

$$K = \frac{Q}{p^{1/2}}$$

*where:*

*K* is the discharge coefficient;

*Q* is the flow in gallons per minute (liters/minute); and

*P* is the pressure in psig (kPa).



## 13 Salt Spray Corrosion Test

13.1 Ferrous anchoring components not protected with a coating complying with 7.5 shall withstand an exposure to a salt spray atmosphere in accordance with 13.4 for 10 days without exhibiting any incipient corrosion.

13.2 For the purposes of this requirement, the term "incipient corrosion" is defined as the first evidence of the destruction of the integrity of the material.

13.3 Three samples of each ferrous part are to be used in this test.

13.4 The samples are to be supported vertically and exposed to salt spray (fog) as specified in the Standard Practice for Operating Salt Spray (Fog) Apparatus, ASTM B117, except that the salt solution is to consist of 20 percent by weight of common salt (sodium chloride).

13.5 The pH value of this solution as collected after spraying in the test apparatus is to be between 6.5 and 7.2, and the specific gravity between 1.126 and 1.157 at 95 °F (35 °C).

## 14 10-Day Moist Ammonia Air Stress Cracking Test

14.1 After being subjected to the conditions described in 14.2 – 14.4, a brass part containing more than 15 percent zinc shall show no evidence of cracking when examined using 25X magnification.

*Exception: Cracking is allowed when it does not impact the ability of the product to comply with the requirements of this Standard.*

14.2 Each test sample is to be subjected to the physical stresses normally imposed on or within a part as the result of assembly with other components. Such stresses are to be applied to the sample prior to and maintained during the test. Samples with threads, intended to be used for installing the product in the field, are to have the threads engaged and tightened to the torque specified in Table 14.1. Teflon tape or pipe compounds are not to be used on the threads.

**Table 14.1**
**Torque Requirements for Threaded Connections**

| Nominal pipe size inches | Torque pound-inches | (N·m) |
|---|---|---|
| 1/2 | 410 | (46.3) |
| 3/4 | 600 | (68) |
| 1 | 1200 | (136) |
| 1-1/4 | 1450 | (164) |
| 1-1/2 | 1550 | (175) |
| 2 | 1650 | (186) |
| 3 | 1800 | (203) |
| 4 | 1900 | (215) |



14.3 Three samples without plating or coatings are to be degreased and then continuously exposed in a set position for ten days to a moist ammonia-air mixture maintained in a glass chamber having a glass cover.

14.4 Aqueous ammonia having a specific gravity of 0.94 is to be maintained at the bottom the glass chamber below the samples. The samples are to be positioned 1-1/2 (+1/2, -0) inches [(38.1 mm) (+12.7 mm, -0 mm)] above the aqueous ammonia solution and supported by an inert tray. The moist ammonia-air mixture in the chamber is to be maintained at atmospheric pressure and at a temperature of 93 ±2 °F (34 ±1 °C).

## 15 Stress-Corrosion Cracking of Stainless Steel Parts Test

15.1 Austenitic stainless steel parts, except braiding and anchoring component fasteners, shall show no evidence of cracking, delamination, or degradation after being subjected to boiling magnesium chloride solution. See 15.2 – 15.5.

*Exception: Cracking is allowed when it does not impact the ability of the product to comply with the requirements of this Standard.*

15.2 A representative section of hose and hose with end connection without plating or coatings is to be degreased prior to being exposed to the magnesium chloride solution. A sample hose is to be bent once to 90° at the minimum radius specified in the manufacturer's installation instructions (the bent portion or part of the bent portion of the hose is to be used as the representative section of hose). In addition to the bent sample, a separate sample representative of the hose secured to the end connection is to be tested.

15.3 The sample is to be placed into a sealed glass chamber that is fitted with a thermometer and a wet condenser. The sealed glass chamber is to be filled approximately one-half full or to a level at least 0.5 inches (1.27 cm) above the test sample with a nominal 44 percent by weight magnesium chloride solution, placed on a thermostatically controlled electrically heated mantel, and maintained at a boiling temperature of 302 ±2 °F (150 ±1 °C). The exposure is to last for 150 hours.

15.4 After the exposure period, the test samples are to be removed from the boiling magnesium chloride solution and rinsed in de-ionized water.

15.5 The test samples are then to be examined using a microscope having a magnification of 25X for any cracking, delamination, or other degradation as a result of the test exposure.

## 16 Elastomeric Parts Test

16.1 An elastomeric part used to provide a seal shall have the following properties when tested as specified in UL 157:

a) For silicone rubber (having poly-organo-siloxane as its constituent characteristic), a minimum tensile strength of 500 psi (3.4 MPa) and a minimum ultimate elongation of 100 percent.

b) For natural rubber and synthetic rubber other than silicone rubber, a minimum tensile strength of 1500 psi (10.3 MPa) and minimum ultimate elongation of 150 percent; or a minimum tensile strength of 2200 psi (15.2 MPa) and a minimum ultimate elongation of 100 percent.

c) Those properties relating to maximum tensile set; minimum tensile strength and elongation after oven aging; and hardness after oven aging, all as specified in UL 157. The oven time and temperature for oven aging is to be based upon the intended service temperature referenced in the manufacturer's instructions, but not less than 60 °C (140 °F).

16.2 The UL 157 provides for the testing of either finished elastomeric parts or sheet or slab material. Sheet or slab material is to be tested when the elastomeric parts are O-rings having diameters of less than 1 inch (25.4 mm). The material tested is to be the same as that used in the product, regardless of whether finished elastomeric parts or sheet or slab material is tested.

## 17 Low Temperature Test for Dry Pipe Systems

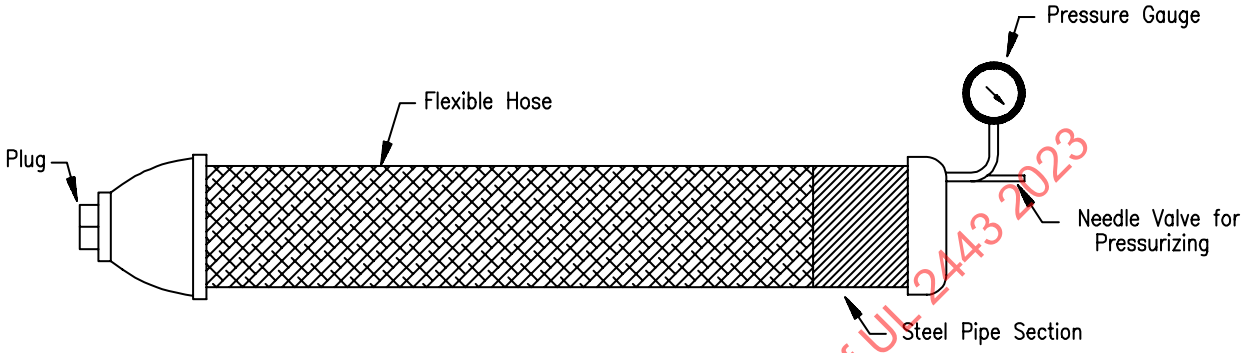
17.1 Following exposure to low temperature conditions described in 17.2, a flexible sprinkler hose with fittings intended for dry systems using elastomeric or polymeric seals shall not show signs of leakage.

17.2 Two samples are to have a nominal 1/8-inch (3.2-mm) depth of water introduced into each test sample when positioned horizontally. One end is to be plugged and the other end of the sample is to be connected to one end of a 1-inch nominal size Schedule 40 pipe fitted with a pressure gauge and attached to an aerostatic pressure source. See Figure 17.1. Each sample is then to be gradually pressurized with air to a pressure of 40 psig (276 kPa) and then sealed. The pressurized assembly is then to be placed horizontally in air maintained at a temperature of minus 40 °F (minus 40 °C) for a period of 24 hours. Following the 24-hour low temperature exposure, the assembly is to be placed in room ambient

temperature of 73 ±5 °F (23 ±3 °C) for an additional 24-hour period. Following the 24-hour exposure to room ambient temperature, there shall be no decrease in the pressure in the assembly from the pressure measured before the low temperature exposure.

**Figure 17.1**

**Low Temperature Test Arrangement**




## 18 Pressure Cycling Test

18.1 When tested as described in 18.2 – 18.3, a flexible sprinkler hose with fittings shall show no signs of leakage or physical damage.

18.2 Samples of the minimum and maximum lengths in both straight and maximum number of minimum radii bend configurations shall be subjected to this test. The samples are to be connected to a pressure cycling apparatus, filled with water and vented of all air. The internal pressure is to be cycled 3,000 times from 0 psig (0 kPa) to twice the rated working pressure to 0 psig (0 kPa) at an approximate rate of 10 cycles per minute.

18.3 During the pressure cycling, observations are to be made for evidence of leakage or physical damage.

## 19 Vacuum Test

19.1 Flexible sprinkler hose with fittings shall withstand a vacuum of minus 8.84 psi (minus 61 kPa) without collapse, leakage, or other deterioration of the flexible sprinkler hose and fitting performance characteristics.

19.2 Two straight length samples are to be installed on a manifold and subjected to a vacuum of minus 8.84 psi (minus 61 kPa) for 1 minute. The samples are then to be removed from the manifold, visually examined for damage, and then subjected to the leakage test at twice the rated working pressure for one minute.

19.3 The samples then are to be visually examined to verify there is no evidence of mechanical damage.

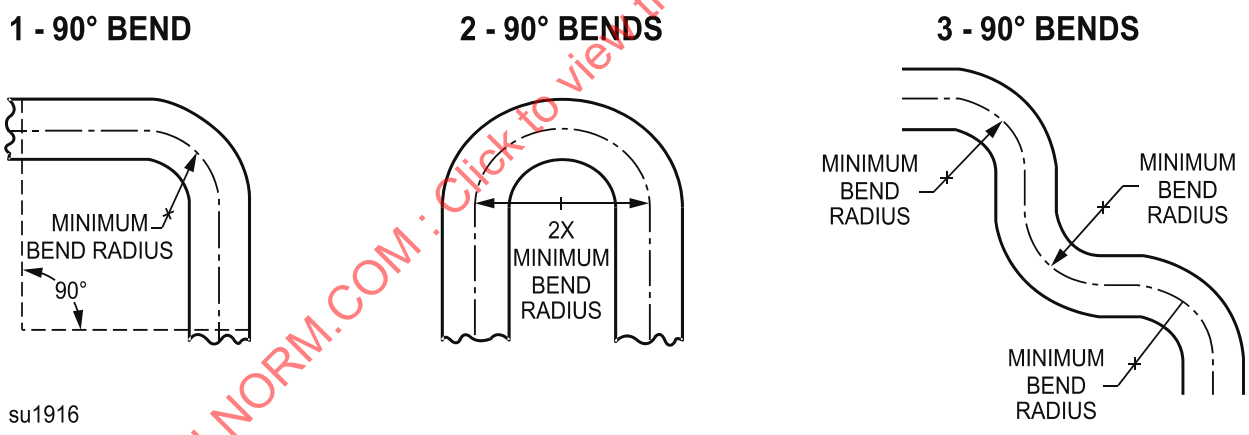
## 20 High Pressure Flow Test

20.1 Flexible sprinkler hose with fittings and its anchoring components shall maintain the attached sprinkler in the intended operating position with an upward movement of no more than 0.125 inch, and the hose shall maintain its integrity while the sprinkler discharges water at 90 percent of the rated pressure of the flexible sprinkler hose measured at the hose inlet.

20.2 UNBRAIDED HOSE TYPES: One sample of the minimum length flexible hose with fittings having one 90° bend and two samples of the maximum length flexible hose with fittings, one tested with one 90° minimum radius bend (as close as practical) and one tested at its maximum number of 90° minimum radius bends (as close as practical) in the same plane (see Figure 20.1), shall be fitted with a sprinkler having the largest K-factor intended to be connected to the assembly. See Figure 20.1. The outlet fitting is to be installed at the midpoint of the longest span between end brackets permitted in the manufacturer's installation instructions. After the sprinkler outlet has been secured with the anchoring components, a string potentiometer or similar device is to be positioned to continuously measure the upward movement of the sprinkler outlet. The initial position of the sprinkler outlet is to be measured unpressurized. A pressure of 90 percent of the rated pressure of the flexible sprinkler hose with fittings shall be applied to the hose inlet. The sprinkler is to be operated and the pressure adjusted to maintain 90 percent of the rated pressure for 30 minutes. Subsequent to the initial operation of the sprinkler, the sustained upward movement of the sprinkler outlet shall be measured and compared to the initial position of the sprinkler outlet to determine compliance with 20.1.

**Figure 20.1**

**Examples of Bend Configurations**






20.3 BRAIDED HOSE TYPES: One sample of the minimum length flexible hose with fittings having one 90° bend and one sample of the maximum length flexible hose with fittings is to be installed with the maximum number of 90° minimum radius bends (as close as practical) in the same plane and fitted with a sprinkler having the largest K-factor intended to be connected to the assembly. See Figure 20.1. The outlet fitting is to be installed at the midpoint of the longest span between end brackets permitted in the manufacturer's installation instructions. After the sprinkler outlet has been secured with the anchoring components, a string potentiometer or similar device is to be positioned to continuously measure and record the upward movement of the sprinkler outlet. The initial position of the sprinkler outlet is to be measured unpressurized. A pressure of 90 percent of the rated pressure of the flexible sprinkler hose with fittings shall be applied to the hose inlet. The sprinkler is to be operated and the pressure adjusted to maintain 90 percent of the rated pressure for 30 minutes. Subsequent to the initial operation of the

sprinkler, the sustained upward movement of the sprinkler outlet shall be measured and compared to the initial position of the sprinkler outlet to determine compliance with 20.1.

20.4 For all hose types (braided and unbraided), the bends are not to be externally supported to maintain their initially established position. Movement, shifting, or settling of the flexible hose portion of the assembly can occur after installation and during the test.

20.5 In addition to the measurement of the upward movement, visual observations shall be made during and after the test to determine that the sprinkler is maintained in the intended operating position and to verify that no leakage, rupture or mechanical damage has occurred.

## 21 Fatigue Test

21.1 Flexible hose with fittings shall withstand without leakage or damage repeated flexing according to the following:

a) In a U-bend arrangement as shown in Figure 21.1, the number of flexing cycles shall be as follows:

1) Flexible hose with fittings having High Flexibility – 50,000 cycles; and

2) Flexible hose with fittings having Limited Flexibility – 100 cycles.

b) In an arc-bend arrangement as shown in , a total of 10 flexing cycles shall be applied to flexible hose with fittings having High or Limited Flexibility.

Following the fatigue tests, the samples shall comply at four times the rated working pressure with the Hydrostatic Pressure and Leakage Test, Section 8.

21.2 Two samples each of the minimum and maximum lengths are to be subjected to the following tests:

a) U-Bend test

The maximum length samples are to be subjected to repeated flexing at a rate of 5 to 30 cycles per minute in a direction parallel to the axis of the end fittings while pressurized to the rated pressure, as shown in Figure 21.1. The maximum length sample is to be placed in a U-shape with the end fittings at a horizontal distance from each other of twice the minimum bend radius referenced in the manufacturer's installation instructions. One end of the sample shall be held in a fixed position and the other end shall be flexed in the vertical plane a distance of 4 times the nominal inlet size of the hose above and below the fixed end which results in a total vertical movement of 8 times the nominal inlet size. The Figure 21.1 test apparatus shall be constructed in a manner to eliminate any repetitive abrasion of the outer diameter of the flexible sprinkler hose and to maintain the specified bend radius during the test procedure.

b) Arc-Bend test

The minimum length samples are to be subjected to repeated flexing at a rate of 5 to 10 cycles per minute without pressure about a circular arc at the minimum bend radius referenced in the manufacturer's installation instructions, as shown in Figure 21.2. One end of the sample shall be held in a fixed position and the other shall be flexed around a circular arc.