



JOINT CANADA-UNITED STATES  
NATIONAL STANDARD

# ANSI/CAN/UL 1821:2019

## STANDARD FOR SAFETY

### Thermoplastic Sprinkler Pipe and Fittings for Fire Protection Service

ULNORM.COM : Click to view the full PDF of UL 1821 2019



Standards Council of Canada  
Conseil canadien des normes

## **SCC FOREWORD**

### **National Standard of Canada**

A National Standard of Canada is a standard developed by a Standards Council of Canada (SCC) accredited Standards Development Organization, in compliance with requirements and guidance set out by SCC. More information on National Standards of Canada can be found at [www.scc.ca](http://www.scc.ca).

SCC is a Crown corporation within the portfolio of Innovation, Science and Economic Development (ISED) Canada. With the goal of enhancing Canada's economic competitiveness and social well-being, SCC leads and facilitates the development and use of national and international standards. SCC also coordinates Canadian participation in standards development, and identifies strategies to advance Canadian standardization efforts.

Accreditation services are provided by SCC to various customers, including product certifiers, testing laboratories, and standards development organizations. A list of SCC programs and accredited bodies is publicly available at [www.scc.ca](http://www.scc.ca).

ULNORM.COM : Click to view the full PDF of UL 1821 2019

UL Standard for Safety for Thermoplastic Sprinkler Pipe and Fittings for Fire Protection Service, ANSI/CAN/UL 1821:2019

Fourth Edition, Dated July 30, 2019

### **Summary of Topics**

***This new edition of ANSI/CAN/UL 1821 includes Canadian requirements for Combustible Piping for Sprinkler Systems, and requirements for Pipe and Fittings Embedded in Concrete.***

The new requirements are substantially in accordance with Proposal(s) on this subject dated January 4, 2019.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of UL.

UL provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will UL be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if UL or an authorized UL representative has been advised of the possibility of such damage. In no event shall UL's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

Users of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold UL harmless from and against any loss, expense, liability, damage, claim, or judgment (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

ULNORM.COM : Click to view the full PDF of UL 1821:2019

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 1821 2019



ANSI/UL 1821-2019

JULY 30, 2019



1

ANSI/CAN/UL 1821:2019

**Standard for Thermoplastic Sprinkler Pipe and Fittings for Fire Protection  
Service**

Prior to the first edition, the requirements for the products covered by this standard were included in the Outline of Investigation for Thermoplastic Sprinkler Pipe and Fittings for Fire Protection Service, Subject 1821.

First Edition – December, 1994

Second Edition – April, 2003

Third Edition – August, 2015

**Fourth Edition**

**July 30, 2019**

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

The most recent designation of ANSI/UL 1821 as an American National Standard (ANSI) occurred on July 30, 2019. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, Preface or SCC Foreword.

This standard has been designated as a National Standard of Canada (NSC).

COPYRIGHT © 2019 UNDERWRITERS LABORATORIES INC.

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 1821 2019

## CONTENTS

Preface .....	5
---------------	---

## INTRODUCTION

1 Scope .....	9
2 Components .....	9
3 Units of Measurement .....	9
4 Undated References .....	10
5 Reference Publications .....	10
6 Terminology .....	10
7 Glossary .....	10
8 Use in Environmental Air Handling Spaces .....	11

## CONSTRUCTION

9 General .....	11
10 Rated Pressure .....	12
11 Rated Temperature .....	12

## PERFORMANCE

12 General .....	12
13 Fire Exposure Test .....	12
13.1 General .....	12
13.2 Fire test with low flowing pressure .....	13
13.3 Fire test with maximum rated flowing pressure .....	17
13.4 Fire exposure test - unfinished basement application .....	17
13.5 Fire exposure test- vertical piping application .....	17
14 Pipe Coefficient of Friction Test .....	18
15 Fitting Equivalent Length Test .....	19
16 Crush Resistance Test .....	19
17 Stress-Corrosion Cracking of Stainless Steel Parts Test .....	19
18 Flexural Test .....	20
19 Impact Resistance Test .....	22
20 Vibration Test .....	22
21 High Pressure Sprinkler Operation Test .....	24
22 Kinking Test .....	25
23 Assembly Test .....	25
24 Leakage and Hydrostatic Pressure Test .....	26
25 Pressure Cycling Test .....	27
26 Temperature Cycling Test .....	27
27 10-Day Moist Ammonia Air Stress Cracking Test .....	27
28 Long-Term Hydrostatic Pressure Test .....	28
29 Environmental Exposure Tests .....	29
29.1 General .....	29
29.2 Test method .....	29
29.3 Water immersion exposure .....	30
29.4 Air oven aging exposure .....	30
29.5 Light and water exposure .....	30
30 Concrete Embedment Test .....	31
31 Marking Permanency Test .....	31

**MANUFACTURING AND PRODUCTION TESTS**

32	General .....	33
33	Wall Thickness Monitoring .....	33

**MARKINGS**

34	General .....	33
35	Pipe .....	33
36	Fittings .....	33

**INSTRUCTIONS**

37	Installation and Design Manual.....	34
----	-------------------------------------	----

**ANNEX A**

	Standards for Components .....	36
--	--------------------------------	----

ULNORM.COM : Click to view the full PDF of UL 1821 2019

## Preface

This is the Fourth Edition of the ANSI/CAN/UL 1821, Standard for Thermoplastic Sprinkler Pipe and Fittings for Fire Protection Service.

UL is accredited by the American National Standards Institute (ANSI) and the Standards Council of Canada (SCC) as a Standards Development Organization (SDO).

This Standard has been developed in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization.

This ANSI/CAN/UL 1821 Standard is under continuous maintenance, whereby each revision is approved in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization. In the event that no revisions are issued for a period of four years from the date of publication, action to revise, reaffirm, or withdraw the standard shall be initiated.

This Fourth Edition Joint National Standard and National Standard of Canada is based on, and now supersedes, the Third Edition of UL 1821, Standard for Thermoplastic Sprinkler Pipe and Fittings for Fire Protection Service, and the Second Edition of ULC/ORD-C199P, Combustible Piping for Sprinkler Systems.

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <http://csds.ul.com>.

UL's Standards for Safety are copyrighted by UL. Neither a printed nor electronic copy of a Standard should be altered in any way. All of UL's Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of UL.

To purchase UL Standards, visit the UL Standards Sales Site at <http://www.shopulstandards.com/HowToOrder.aspx> or call tollfree 1-888-853-3503.

This Edition of the Standard has been formally approved by the UL Standards Technical Panel (STP) on Thermoplastic Sprinkler Pipe and Fittings for Fire Protection Service, STP 1821.

This list represents the STP 1821 membership when the final text in this standard was balloted. Since that time, changes in the membership may have occurred.

### STP 1821 Membership

Name	Representing	Interest Category	Region
J. Bittenbender	Rehau Inc.	Producer	USA
A. Black	Carmel Fire Protection Associates	AHJ/Regulator	USA
M. Carassoulis	Insurance Engineering Services	General Interest	Ontario
G. Carrier	PGA Experts Inc.	General Interest	Quebec
G. Colavecchia	Centurion Fire Control	Supply Chain	Ontario
R. Fleming	National Fire Sprinkler Association	General Interest	USA
J. Gardiner	North Bay Fire & Emergency Services	AHJ/Regulator	Ontario
L. Gill	IPEX USA LLC	Producer	Ontario
Diane Haitcock	Underwriters Laboratories Inc.	STP Chair – Non- voting	USA
M. Harwood	iv3CUS/iv3 Solutions	General Interest	Ontario
J. Hebenstreit	UL LLC	Testing & Standards Organization	USA
K. Hubbard	City of Airdrie	AHJ/Regulator	Alberta
M. Klaus	National Fire Protection Association	Testing & Standards Organization	USA
W. Koffel	Koffel Associations Inc.	General Interest	USA
J. Lee	Windsor Fire & Rescue Services	AHJ/Regulator	Ontario
S. Lippka	Johnson Controls	Producer	USA
J. Paschal	Aquatherm	Producer	USA
M. Pilette	Mechanical Designs Ltd.	General Interest	USA
S. Pugsley	Seneca College	General Interest	Ontario
R. Ray	CyCybor Fire Protection Company	Supply Chain	USA
M. Savage	Marion County, Fl.	AHJ/Regulator	USA
M. Sewell	Victaulic	Producer	USA
E. Skare	Uponor	Producer	USA
D Townley	Lubrizol Advanced Materials	Supply Chain	USA
S. Watt	Emergency Management BC	AHJ/Regulator	British Columbia
Kevin HF Wu	ULC Standards	STP Project Manager – Non-voting	Canada

International Classification for Standards (ICS): 13.220.20

For further information on UL standards, please contact:

Underwriters Laboratories Inc.  
171 Nepean Street, Suite 400  
Ottawa, Ontario K2P 0B4  
Phone: 1-613.755.2729  
E-mail: [cec@ul.com](mailto:cec@ul.com)  
Web site: [ul.com](http://ul.com)

This Standard is intended to be used for conformity assessment.

The intended primary application of this standard is stated in its scope. It is important to note that it remains the responsibility of the user of the standard to judge its suitability for this particular application.

CETTE NORME NATIONALE DU CANADA EST DISPONIBLE EN VERSIONS FRANÇAISE ET ANGLAISE

ULNORM.COM : Click to view the full PDF of UL 1821:2019

No Text on This Page

[ULNORM.COM](http://ULNORM.COM) : Click to view the full PDF of UL 1821 2019

## INTRODUCTION

### 1 Scope

1.1 These requirements cover thermoplastic pipe and fittings for use in wet pipe sprinkler systems for fire protection service.

1.2 Thermoplastic pipe and fittings covered by these requirements are intended for use in sprinkler systems in any of the following types of occupancies:

- a) Light hazard occupancies as defined in the Standard for Installation of Sprinkler Systems, NFPA 13;
- b) Residential occupancies as defined in the Standard for Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes, NFPA 13D; and
- c) Residential occupancies as defined in the Standard for Installation of Sprinkler Systems in Low-Rise Residential Occupancies, NFPA 13R.

1.3 The pipe and fittings covered by these requirements are intended to be installed in accordance with the Standard for Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes, NFPA 13D; the Standard for Sprinkler Systems in Low-Rise Residential Occupancies, NFPA 13R; or the Standard for Installation of Sprinkler Systems, NFPA 13.

1.4 The requirements covered by this standard do not address compatibility of plastic pipe and fittings with materials or products that they may be in contact with in storage, handling, or use.

### 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. See Annex [A](#) for a list of standards for components referenced in this standard.

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 Undated References

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.

## 5 Reference Publications

ASME B1.20.1, *Standard for Pipe Threads, General Purpose, Inch*

ASTM D 396, *Standard for Specification for Fuel Oils*

ASTM D 638, *Standard Test Method for Tensile Properties of Plastics*

ASTM D 1598, *Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure*

ASTM D 2444, *Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)*

ASTM D2837, *Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products*

NFPA 13, *Standard for the Installation of Sprinkler Systems*

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

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

NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*

## 6 Terminology

6.1 The term "pipe", "piping", or "fitting" as used in these requirements refers to all thermoplastic pipe or fittings or any part thereof covered by these requirements unless specifically noted otherwise.

## 7 Glossary

7.1 For the purposes of these requirements, the following definitions apply.

7.2 FLEXIBLE THERMOPLASTIC PIPE – A fire sprinkler pipe that has sufficient flexibility to achieve directional changes, provided turns are not made with the pipe using a bending radius less than the minimum specified in the installation and design manual.

7.3 MULTIPURPOSE PIPING SYSTEM – A piping system within residential occupancies (NFPA 13R), dwellings, and manufactured homes (NFPA 13D), intended to serve both domestic and fire protection needs.

7.4 NPS (NOMINAL PIPE SIZE) – A dimensionless designator for pipe sizes defined in standards including Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR), ASTM F442/F442M and for PEX it is Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems, ASTM F877 used to replace terms such as "Nominal Diameter" and "Nominal Size."

7.5 RATED PRESSURE – The maximum internal water pressure to which the piping is intended to be subjected to in the sprinkler system.

7.6 RATED TEMPERATURE – The maximum ambient temperature for which the piping is intended to be exposed for the fire sprinkler application.

7.7 THERMOPLASTIC – A plastic capable of being repeatedly softened by heating and hardened by cooling through a particular temperature range that is characteristic of the plastic. In the softened state, it is able to be shaped by processes such as molding or extrusion.

## 8 Use in Environmental Air Handling Spaces

8.1 Thermoplastic pipe intended for use in ceiling cavity environmental air handling spaces shall comply with (a) and (b) below:

a) Pipe shall be tested in accordance with the requirements in the Standard for Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics, UL 1887, and comply with the applicable requirements of the Standard for the Installation of Air Conditioning and Ventilating Systems, NFPA 90A.

b) Thermoplastic pipe intended for use in ceiling cavity environmental air handling spaces, shall comply with the applicable requirements of the National Building Code of Canada, and shall be tested in accordance with the Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies, CAN/ULC-S102, if they are thermoset pipes, or in accordance with the Standard Method of Test for Surface Burning Characteristics of Floor, Floor Covering and Miscellaneous Materials and Assemblies, CAN/ULC-S102.2, if they are thermoplastic pipes. Samples shall consist of two 7.4 m (24 ft.) lengths of pipe spaced 200 mm (8 in.) on center. Sprinkler piping intended to be used within a plenum shall have a flame-spread rating of not more than 25, and a smoke developed classification of not more than 50.

## CONSTRUCTION

### 9 General

9.1 Pipe and fittings shall be in sizes 3/4 NPS and larger diameter and free from visible cracks, holes, foreign inclusions, or other defects.

*Exception: Pipe and fittings for use in network systems (NFPA 13D) may be in sizes 1/2 NPS and larger diameter and shall be free from visible cracks, holes, foreign inclusions, or other defects.*

9.2 Pipe and fittings shall be joined by a means applicable for the type of piping material such as by solvent cement, fusion, or mechanical means.

9.3 Threaded thermoplastic fittings intended for transition to other piping material shall be threaded in accordance with 9.5. Threaded thermoplastic fittings shall be made in accordance with the American Society for Testing and Materials (ASTM) requirements applicable to the thermoplastic material being used, as well as comply with the requirements of this Standard.

9.4 Male or female threaded thermoplastic fittings intended for direct connection to a sprinkler, with or without a metal insert, shall have threads that comply with 9.5, in addition to complying with the requirements of this Standard.

9.5 Threaded thermoplastic fittings intended for transition to other piping material in 9.3 and connection to sprinklers in 9.4 shall be threaded with threads conforming to the following:

- a) Standard for Pipe Threads, General Purpose, Inch, ASME B1.20.1;
- b) Standard for Dryseal Pipe Threads (Inch), ASME B1.20.3; or
- c) Where piping intended for use in installations where sprinkler fittings incorporate pipe threads other than NPT type threads, pipe threads complying with a national pipe thread standard compatible with those fittings shall be permitted.

9.6 Pipe and fitting materials shall have a minimum flammability classification of HB when tested in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

## 10 Rated Pressure

10.1 The pipe and fittings covered by these requirements shall have a rated pressure of 175 psig (1.21 MPa) or higher.

*Exception: Pipe and fittings for use in NFPA 13D multipurpose piping systems may have a rated pressure of 130 psig (0.90 MPa) or higher.*

## 11 Rated Temperature

11.1 The pipe and fittings covered by these requirements shall have a rated temperature of 120°F (49°C) or higher.

## PERFORMANCE

### 12 General

12.1 Representative sample pipe and fitting assemblies shall be subjected to the tests described in Sections [13](#) – [31](#).

### 13 Fire Exposure Test

#### 13.1 General

13.1.1 When tested as specified in [13.1.2](#) – [13.5.1](#), pipe and fitting assemblies:

- a) Shall not burst, separate, or leak; and
- b) Shall maintain the sprinkler in the intended operating position.

Following the fire exposure, the pipe and fitting assemblies shall withstand an internal hydrostatic pressure equal to the maximum rated pressure for 5 minutes without rupture or leaks.

*Exception: Pipe and fittings intended to be protected by any of the constructions listed in (a) – (b) are not required to be subjected to the fire exposure test:*

- a) 3/8 inch (9.5 mm) thick or thicker gypsum wallboard;
- b) A suspended membrane ceiling with lay-in panels or tiles having a weight of not less than 0.35 lb/ft<sup>2</sup> (1.76 kg/m<sup>2</sup>) when installed with metallic support grids; or
- c) 1/2 inch (12.7 mm) plywood soffits.

13.1.2 The test arrangement used to test pipe and fittings shall be in accordance with the installation and design manual and incorporate:

- a) The minimum number of hangers with spacing and locations specified;
- b) The type of sprinkler(s) (residential, quick response, or standard) with which the product is intended to be used, the maximum temperature rating classification specified, and the minimum sprinkler restraint methods;
- c) The minimum ceiling protection, if protection is specified; and
- d) The maximum sprinkler deflector distance below the ceiling.

13.1.3 Sprinklers are to be selected with regard to the response time characteristics for the type (residential, quick response, or standard) of sprinklers specified in the installation and design manual. The response time characteristic selected is to be among the slower of sprinklers currently available.

13.1.4 The fire source employed in these tests is to consist of a square steel pan containing heptane. The pan is to be a 5 ft<sup>2</sup> (0.46 m<sup>2</sup>) pan 12 inches (305 mm) deep, constructed of steel not less than 1/4 inch (6.4 mm) thick. The pan is to be liquid-tight and the top edges are to be reinforced by a continuous steel angle section. The fire source pan is to be filled with 6-1/4 gallons (23.7 L) of heptane having the characteristics specified in 13.1.5. The pan is to be placed in a square 10 ft<sup>2</sup> (0.92 m<sup>2</sup>) liquid tight pan, 12 inches (305 mm) deep, constructed of steel not less than 1/4 inch (6.4 mm) thick with the top edge reinforced by a continuous steel angle. The 10 ft<sup>2</sup> (0.93 m<sup>2</sup>) pan is to be filled with water and fresh water is to be flowed into it during the fire test.

13.1.5 The heptane is to have the following characteristics described in [Table 13.1](#).

**Table 13.1**  
**Heptane characteristics**

Minimum Initial Boiling Point	190°F (88°C)
Maximum Dry Point	212 °F (100 °C)
Specific Gravity (60°F/60°F) (15.6°C/15.6°C)	0.69 – 0.73

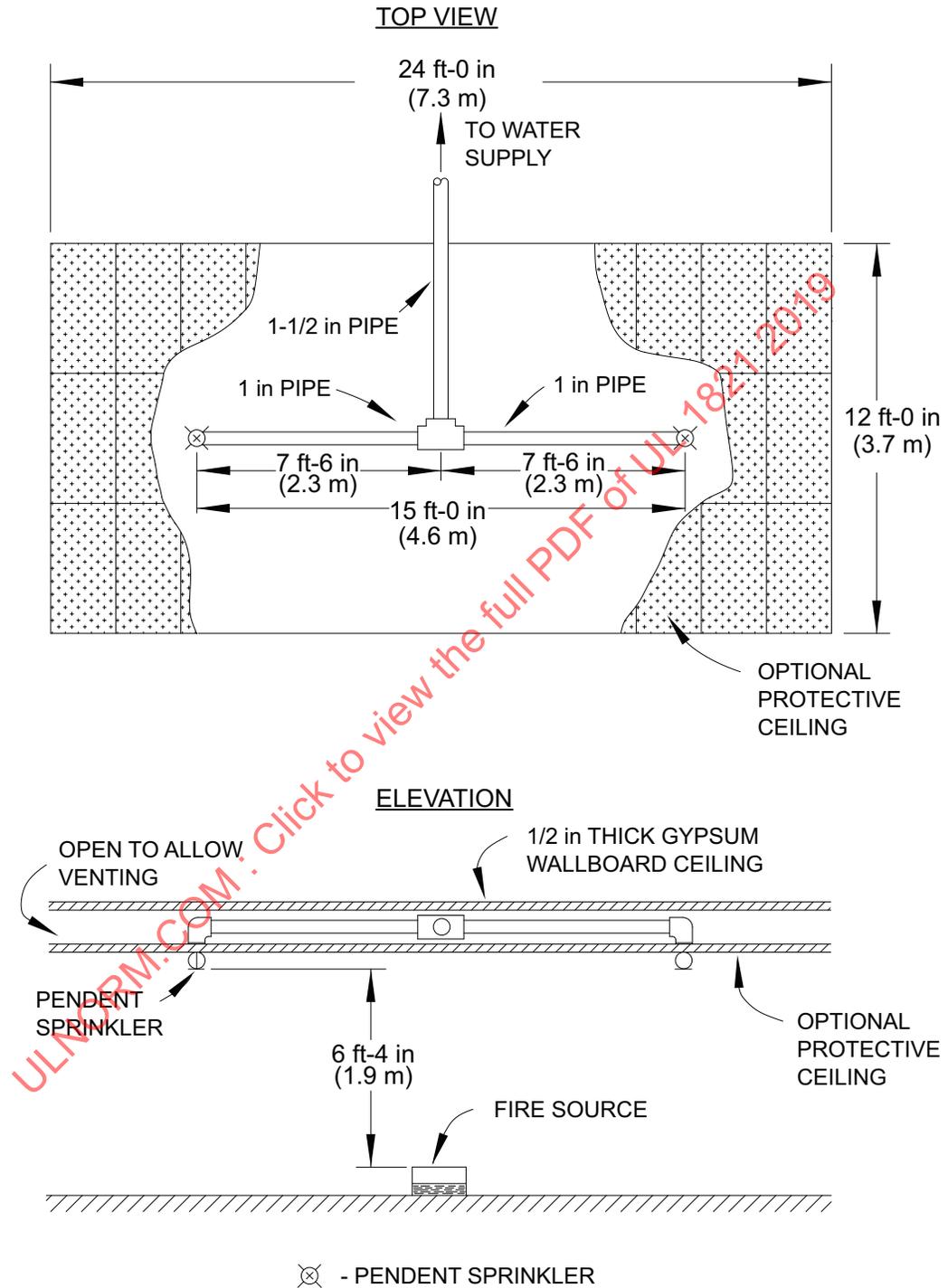
13.1.6 The test room employed for these tests is to be essentially draft-free and is not to be smaller than 30 by 30 by 15 feet (9.1 by 9.1 by 4.6 m) high. A 12 foot (3.7 m) wide by 24 foot (7.3 m) long test ceiling is to be installed approximately 8 feet (2.4 m) above the floor.

13.1.7 The piping arrangement is to be attached to a water supply capable of supplying a pressure equal to the maximum rated pressure at the inlet of the piping. The system water supply is to be equipped with flowmeters and pressure gauges.

## 13.2 Fire test with low flowing pressure

13.2.1 The test is to be conducted with two closed pendent sprinklers installed at a maximum 15 foot (4.6 m) spacing at the ends of a balanced flow piping arrangement. The piping arrangement is to be connected to the water-supply. The piping is to have an initial static pressure of 100 to 120 psi (689 to 827 kPa), which is then to be adjusted to maintain the specified flow after sprinkler operation. See [Figure 13.1](#) for the general test arrangement.

**Figure 13.1**  
**General test arrangement – sprinkler other than sidewall**



s3546d

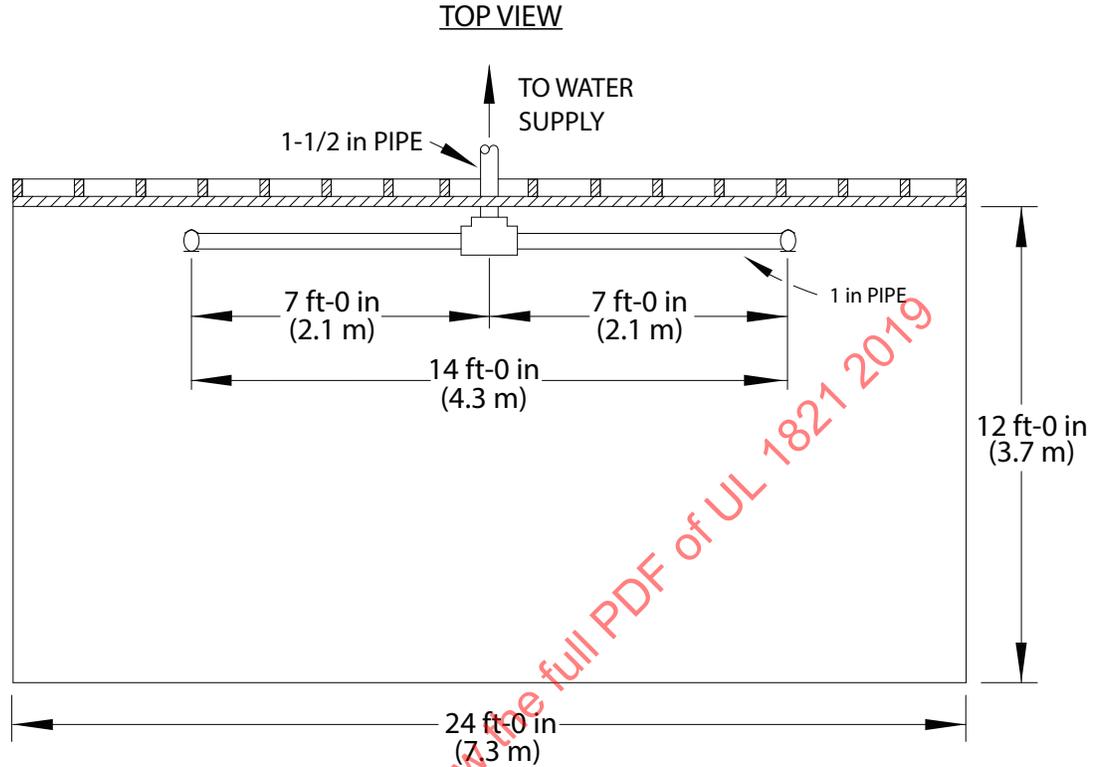
Note 1 – Fire source is to be centered directly under piping tee.

Note 2 – The distance from the sprinkler deflector to the ceiling for exposed piping is to be the maximum as specified in the installation and design manual but in no case greater than 12 inches (305 mm).

13.2.2 If the piping is intended to be installed at the ceiling-wall junction, a test is also to be conducted with two standard sidewall sprinklers installed at a maximum 14 foot (4.3 m) spacing at the ends of a balanced flow piping arrangement. The piping arrangement is to be connected to the water-supply. The piping is to have an initial static pressure of 100 to 120 psi (689 to 827 kPa), which is then to be adjusted to maintain the specified flow after sprinkler operation. See [Figure 13.2](#) for general test arrangement.

ULNORM.COM : Click to view the full PDF of UL 1821 2019

**Figure 13.2**  
**General test arrangement – sidewall sprinkler**



○ - HORIZONTAL SIDEWALL SPRINKLER

s3548c

Note 1 – Fire source is to be directly under the piping tee.

Note 2 – The distance from the sidewall sprinkler deflector to the ceiling is to be the maximum specified in the installation and design manual, but in no case greater than 12 inches (305 mm), nor greater than the distance specified by the sprinkler manufacturer.

13.2.3 If ceiling protection other than referenced in [13.1.1](#) is specified in the installation and design manual, a ceiling representing the minimum protection is to be installed below the piping arrangement. See [Figure 13.2](#). If the pipe is intended to be installed without protective materials, the pipe is to be tested in the exposed condition with the sprinkler deflectors installed at the maximum distance below the ceiling specified in the installation and design manual.

13.2.4 The test timer and temperature-measuring equipment are to be started when the test pan is ignited. The sprinklers are to be allowed to operate automatically. After operation of each sprinkler, the flow is to be adjusted to maintain a total flow equal to a maximum of 22.5 gpm (1.41 L/s) per sprinkler.

13.2.5 After 10 minutes, the fire source in the pan is to be extinguished and the water supply to the sprinklers is to be turned off a maximum of 5 minutes after the fire source is extinguished.

### 13.3 Fire test with maximum rated flowing pressure

13.3.1 The tests described in [13.2.1](#) – [13.2.5](#) are to be repeated with the pressure equal to the maximum rated pressure introduced into the inlet of the piping arrangement. After sprinkler operation, 90 percent of the maximum rated pressure is to be maintained.

### 13.4 Fire exposure test - unfinished basement application

13.4.1 Piping assemblies intended for installation without protective materials referenced in [13.1.1](#) and in unfinished basement ceilings, shall comply with the Fire Exposure Tests described in Section [13](#) except for the following:

- a) The test room described in [13.1.6](#) shall have a simulated unfinished basement ceiling installed using sprinklers which shall be spaced at maximum spacing and configuration to protect the maximum basement ceiling area specified in the Installation and Design Manual. Permanent blocking installed at the full depth of the joist intended to reduce the escape of heat from the joist cavity is acceptable to divide larger areas;
- b) Exposed structural members shall be located at the ceiling height, structural member depth, spacing, and construction to accomplish maximum and minimum sprinkler response times (Commonly between four sprinklers and between two sprinklers on the same pipe installed parallel to the joists, respectively); and
- c) Piping assemblies shall be installed in the following two configurations:
  - 1) Branch lines parallel to the joists and in the joist space above the fire source at the maximum depth in the joist space; and
  - 2) Main line perpendicular to the joists located at the bottom cord of the joists above the fire source.

The location of the piping in both configurations [13.4.1](#) (c)(1) and (2) shall be directly above the fire source.

### 13.5 Fire exposure test- vertical piping application

13.5.1 Piping assemblies intended for installation as a vertical supply (riser) without protective materials referenced in [13.1.1](#), shall comply with the Fire Exposure Tests described in Section [13](#) except for the following:

- a) The riser shall be installed vertically along a wall and horizontally at a ceiling height representative of the configuration specified in the Installation and Design Manual. Where the design manual allows piping to come up through a basement slab or protrude through the wall at a

height less than the height of the steel pan containing the heptane, testing with the piping system vertical riser beginning at the height equal to the steel pan shall be considered representative;

- b) The fire source shall be located along the wall below the vertical riser;
- c) Sprinklers shall be located at the maximum distance from the riser specified in the Installation and Design Manual; and
- d) Tests shall be conducted with the piping located at two locations:
  - 1) Vertically along a wall; and
  - 2) Vertically in a corner.

#### 14 Pipe Coefficient of Friction Test

14.1 The Hazen-Williams pipe coefficient of friction (C) is to be determined as specified in 14.2 and 14.3, and shall not be less than the value specified in the installation and design manual.

14.2 A pipe sample, at least 20 feet (6.1 m) long, is to be installed in a friction loss test apparatus. A piezometer is to be installed in each end of the pipe sample and is to be connected to a differential pressure gauge. The water flow through the test sample is to be measured using a flow measuring device.

14.3 At least five different water flows at velocities between 10 and 18 ft/s (3.1 and 5.5 m/s) are to be established through the test sample and the pressure drop between piezometers at each flow is to be recorded. The test is to be repeated with the pipe sample removed from the line and the piezometers coupled together. The pressure drop values obtained are then to be subtracted from the results of the test with the pipe sample in the line to obtain the pressure drop of the pipe samples. The Hazen-Williams coefficient of friction is to then be calculated using the following formula:

$$C = \frac{2.26 Q}{d^{2.63} p^{0.54}}$$

where:

*Q* = the water flow, gallons per minute;

*C* = friction loss coefficient;

*d* = the measured inside diameter of the pipe, inches; and

*p* = the pressure loss in pounds per square inch per foot of pipe.

For SI units, the following equation shall be used:

$$C = \frac{(605000)^{0.54} Q_m}{p_m^{0.54} d_m^{2.63}}$$

where:

*p<sub>m</sub>* = the pressure loss in bar per meter of pipe;

*Q<sub>m</sub>* = flow in L/min;

$C$  = friction loss coefficient; and

$d_m$  = the measured inside diameter of the pipe in mm.

## 15 Fitting Equivalent Length Test

15.1 When tested as described in [15.2](#) and [15.3](#), the head loss of fittings, expressed in equivalent length of pipe, shall not be more than 2 equivalent feet (610 equivalent mm) higher than the values published in the installation and design manual.

15.2 Samples of fittings are to be installed in a friction loss test apparatus. A piezometer is to be installed on two outlets of the fittings and connected to a differential pressure gauge. The water flow through the test sample is to be measured using a flow measuring device.

15.3 At least five different water flows at velocities between 10 and 18 ft/sec (3.1 and 5.5 m/s) are to be established through the test sample and the pressure drop between piezometers at each flow is to be recorded. The test is to be repeated with the test fittings removed from the line and the piezometers coupled together. The pressure drop values obtained are to be subtracted from the results of the test with the test fitting to obtain a pressure drop for the fitting. Using the Hazen-Williams coefficient of friction specified for the pipe, the equivalent length, in feet (m) of pipe, is to be calculated.

## 16 Crush Resistance Test

16.1 After being subjected to the crush resistance test specified in [16.2](#), representative samples of pipe shall comply with the Leakage and Hydrostatic Pressure Test, Section [24](#).

16.2 Samples of empty unpressurized pipe are to be placed on top of a 1-5/8 inch (41.3 mm) wide by minimum 1 inch (25.4 mm) high steel material having 0.125 inch (3.17 mm) radius round edges. A load is to be applied to the top of the pipe sample by a metal flat plate attached to a tension-compression machine. The test load is to be increased to 200 pounds-force (890 N) using a crosshead speed of 0.5 in/min (12.7 mm/min) and held for 5 minutes.

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

17.1 Austenitic stainless steel parts shall show no evidence of cracking, delamination, or degradation after being subjected to boiling magnesium chloride solution. See [17.2](#) – [17.5](#).

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

17.2 At least three samples in a representative size without plating or coatings are to be degreased prior to being exposed to the magnesium chloride solution.

17.3 The samples are to be placed into a flask that is fitted with a thermometer and a wet condenser 30-inches (762-mm) long. The flask is to be filled one-half full with a 42 percent by weight magnesium chloride solution, placed on a thermostatically controlled electrically heated mantel, and maintained at a boiling temperature of  $302 \pm 2^\circ\text{F}$  ( $150 \pm 1^\circ\text{C}$ ). The sample parts are to be unassembled. The duration of the exposure shall be 150 hours.

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

17.5 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.

## 18 Flexural Test

18.1 Representative samples of piping joints shall sustain a bending moment equivalent to twice the weight of the water filled pipe over twice the hanger spacing distance without kinking, leaking, or other signs of permanent damage.

18.2 The samples are to be installed using two pipe hangers that are located at twice the maximum spacing specified in the installation and design manual. The pipe joint is to be centered between hangers. The pipe assembly is to be filled with water and pressurized to the rated pressure. A point load of one-half the weight of the water filled pipe between the hangers is to be applied to the sample at the center point between the two hangers and held for 1 minute. See [Figure 18.1](#). A test method using shorter hanger spacings with a corresponding increase in applied load to achieve an equivalent bending moment is also allowed, using the following formula:

$$P = \frac{2\omega L_r^2 - \omega L_t^2}{2L_t}$$

where:

$P$  = the point load to be applied in pounds (kilograms);

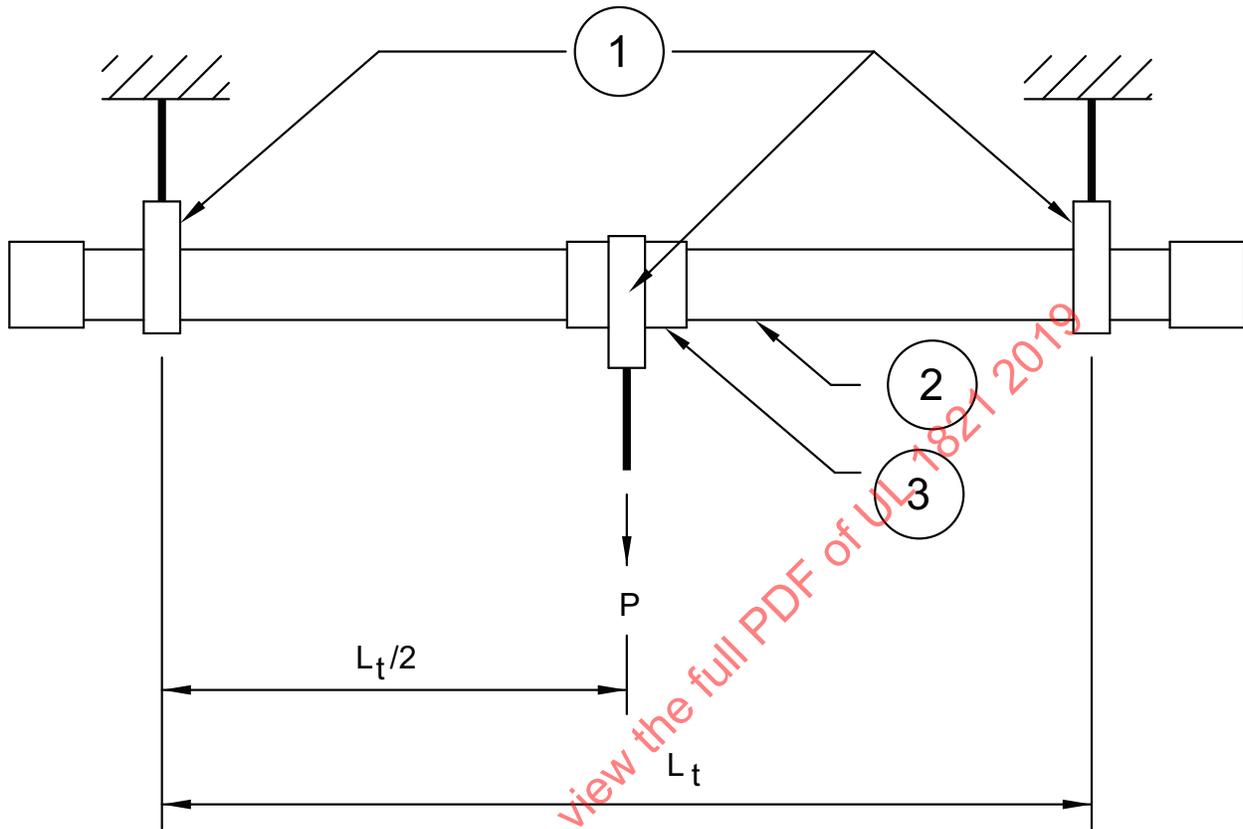
$\omega$  = the weight per unit length of water filled pipe in pounds per foot (kilograms per meter);

$L_r$  = twice the maximum support spacing distance specified in the installation and design manual in feet (meters); and

$L_t$  = the distance between supports in test set-up in feet (meters).

ULNORM.COM : Click to view the full PDF of UL 1821 2019

**Figure 18.1**  
**Flexural test configuration**



s3640b

1 – HANGER DESIGN PER MANUFACTURER'S INSTRUCTONS

2 – PIPE

3 – FITTING

ULNORM.COM : Click to view the full PDF of UL 1821 2019

## 19 Impact Resistance Test

19.1 Samples of pipe are to be conditioned at 0, 32, and 70°F (minus 18, 0, and 21.1°C) for 24 hours. Immediately after conditioning, each pipe sample is to be subjected to an impact by a 2 pounds-mass (0.9 kg) weight in the form of a 1.25 inch (31.7 mm) diameter steel cylinder with a flat impact face having rounded edges. The impact value is to be 10 foot-pounds (13.5 J) for pipe sizes up to and including 1 NPS and 15 foot-pounds (20.3 J) for pipe sizes larger than 1 NPS. The impact testing is to be conducted at room temperature on each sample (within 5 minutes of their removal from the conditioning temperature) in accordance with the method described in the Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight), ASTM D2444.

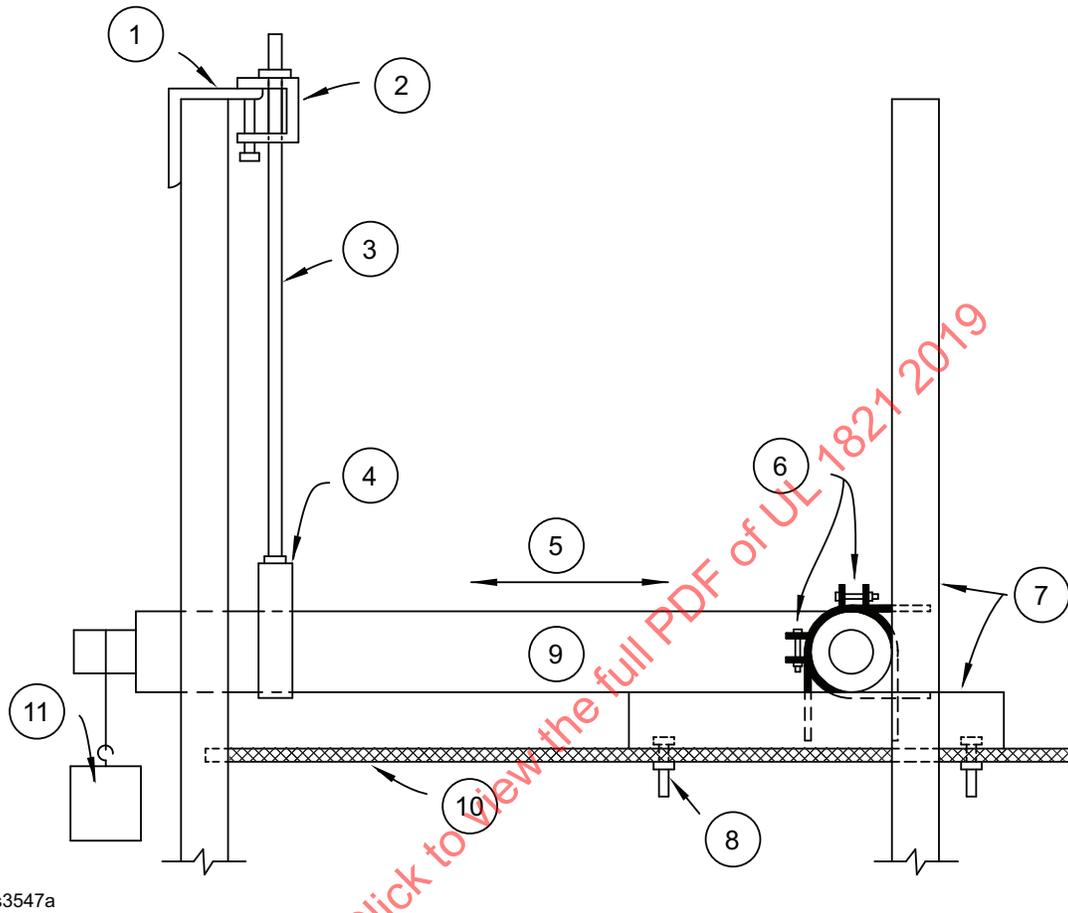
19.2 After being subjected to the impact specified in [19.1](#), representative samples of the pipe in the smallest and largest size for each impact value shall comply with the Leakage and Hydrostatic Pressure Test, Section [24](#).

## 20 Vibration Test

20.1 Pipe and fitting assemblies shall withstand the effects of vibration for 30 hours without deterioration of performance characteristics. Following the vibration test, each test assembly shall comply with the specified requirements in the Leakage and Hydrostatic Pressure Test, Section [24](#).

20.2 For pipe and fitting sizes greater than nominal 1/2 NPS, representative pipe and fitting arrangements, assembled in accordance with the installation and design manual and consisting of approximately 2 foot (610 mm) lengths of pipe attached to each outlet of a tee, are to be placed horizontally and attached to a vibration table. The pipe branch lines are to be attached to the vibration table on each side of the tee outlets in accordance with the installation and design manual. The side tee outlet branch line is to have a fitting on the end of the branch line pipe and is to be supported with a pipe support located near the end fitting. The pipe support which is most expected to cause pipe damage or abrasion is to be selected based on the type of pipe supports specified in the installation and design manual. The pipe support is to be located at the maximum distance from the end fitting as specified in the installation and design manual and attached to a fixed (nonvibrating) support. A load equivalent to the weight of a 4 foot (1.2 m) length of water-filled pipe is to hang freely from the fitting located on the end of the side outlet pipe branch line. See [Figure 20.1](#) for the general test arrangement.

**Figure 20.1**  
**General test arrangement – vibration test**



- 1 – STEEL ANGLE
- 2 – BEAM CLAMP
- 3 – THREADED ROD
- 4 – HANGER
- 5 – DIRECTION OF MOVEMENT
- 6 – PIPE CLAMP
- 7 – STEEL CHANNEL
- 8 – BOLT
- 9 – SAMPLE
- 10 – TABLE
- 11 – WEIGHT

20.3 For nominal 1/2 NPS pipe and fitting sizes, representative pipe and fitting arrangements, assembled in accordance with the installation and design manual and consisting of approximately 2 foot (610 mm) lengths of pipe, a multi-port manifold fitting, and a multi-port sprinkler adapter fitting are to be placed horizontally and attached to a vibration table. The outer ports of the manifold fitting are to be attached to the inner ports of the sprinkler adapter fitting with pipe. The other ports of both the manifold fitting and sprinkler adapter fitting are to be attached to pipe. The sprinkler adapter fitting is to be attached to the vibration table in accordance with the installation and design manual. The manifold fitting and the outer pipe branch lines of the sprinkler adapter fitting are to be attached to a fixed (nonvibrating) support. The inner pipe branch lines of the manifold fitting are to be supported near the end fitting with pipe supports attached to the vibration table. The pipe supports which are most expected to cause pipe damage or abrasion are to be selected from those specified in the installation and design manual.

20.4 For flexible piping products, representative pipe and fitting arrangements, assembled in accordance with the installation and design manual and consisting of approximately 2 foot (610 mm) lengths of pipe are to be bent to the minimum bending radius specified in the installation and design manual and attached to a vibration table. One end of the pipe is to be attached to the vibration table and the other end is to be attached to a fixed (nonvibrating) support. The pipe supports which are most expected to cause pipe damage or abrasion are to be selected from those specified in the installation and design manual.

20.5 Unpressurized sample assemblies are to be subjected to a vibration of 0.02 inch (0.51 mm) amplitude at a varying frequency ranging from 18 to 37 hertz for a period of 5 hours. The cycle period is to be  $25 \pm 5$  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 discovered. If no resonant frequency is detected, then tests are to be conducted at the amplitudes, frequencies, and time periods noted in [Table 20.1](#). Amplitude is the maximum displacement of sinusoidal motion from position of rest or one-half of the total table displacement.

**Table 20.1**  
**Amplitude of vibration**

Amplitude, inch (mm)	Total displacement, inch (mm)	Frequency, hertz	Time, hours
0.010 (0.25)	0.020 (0.51)	28	5
0.020 (0.51)	0.040 (1.02)	28	5
0.075 (1.90)	0.150 (3.81)	28	5
0.020 (0.51)	0.040 (1.02)	18 – 37 (variable)	5
0.035 (0.89)	0.070 (1.78)	18 – 37 (variable)	5

20.6 After being subjected to the required vibration, the sample is to be examined for wear or damage, and then subjected to the Leakage and Hydrostatic Pressure Test, Section [24](#).

## 21 High Pressure Sprinkler Operation Test

21.1 Representative pipe and fitting assemblies, installed in accordance with the installation and design manual, shall be capable of being installed in a manner that provides sufficient support to maintain the sprinkler in its intended operating and discharge position when tested as specified in [21.1](#) – [21.4](#).

*Exception: Fittings for direct connection to a sprinkler and incorporating a means for rigid attachment of the fitting to the building structure are not to be tested.*

21.2 The test assembly is to consist of a 10 foot (3.05 m) length of pipe connected to a water supply. An elbow with at least a 2 foot (610 mm) drop to the sprinkler is to be installed on the end of the pipe. A second sprinkler is to be installed at the midpoint of the pipe sample having at least a 2 foot (610 mm) drop to the sprinkler from a tee.

21.3 A suspended ceiling is to be installed at the sprinkler level with sprinkler escutcheons installed. The suspended ceiling material, sprinklers, and sprinkler escutcheons used for this test are to be selected from the options provided in the installation and design manual based on the following:

- a) The ceiling material that is most expected to interfere with the discharge characteristics of the sprinkler is to be used.
- b) The distance of the sprinkler deflector below the bottom of the escutcheon is to be at a minimum.
- c) The escutcheon used is to provide the least amount of support for the sprinkler.

21.4 The piping and sprinkler arrangement is to be pressurized to the maximum rated pressure. The sprinkler then is to be operated with a heat source and discharged at a pressure of at least 90 percent of the maximum rated pressure for 2 minutes. Visual observations are to be made of the operating and discharging position of the sprinkler.

## 22 Kinking Test

22.1 Representative samples of flexible pipe in each size shall not kink at or above the minimum bending radius values specified in the installation and design manual when tested in accordance with [22.2](#) and [22.3](#).

22.2 Samples of each size pipe are to be conditioned at  $0 \pm 5^{\circ}\text{F}$  (minus  $18 \pm 3^{\circ}\text{C}$ ),  $70 \pm 5^{\circ}\text{F}$  ( $21 \pm 3^{\circ}\text{C}$ ), and the maximum rated temperature for 24 hours.

22.3 Immediately after conditioning, each sample is to be bent with the bending radius of the pipe gradually reduced until kinking occurs.

## 23 Assembly Test

23.1 When assembled and cured as specified in the installation and design manual, the samples shall withstand for 2 hours, without rupture, separation, or leakage, an internal hydrostatic pressure equivalent to the rated pressure or higher, as specified in the installation and design manual, and other internal hydrostatic pressures as they relate to cure times specified in the installation and design manual.

23.2 Representative samples of pipe and fittings in the largest size for each specified temperature and cure time are to be assembled in accordance with the installation and design manual.

23.3 The assembly of the pipe and fittings is to be at temperatures and minimum cure times specified in the installation and design manual, including assembly at  $32^{\circ}\text{F}$  ( $0^{\circ}\text{C}$ ) or lower temperature as specified in the installation and design manual and at  $120^{\circ}\text{F}$  ( $49^{\circ}\text{C}$ ) or higher as specified in the installation and design manual.

23.4 The pipe, fittings, solvent cement, and tools necessary for assembly are to be conditioned at each specified temperature for a minimum of 16 hours prior to assembling. Each assembly is to be made at the specified conditioning temperature and subjected to the hydrostatic pressure test specified in [23.2](#) following the minimum curing times specified in the installation and design manual.

## 24 Leakage and Hydrostatic Pressure Test

24.1 Representative pipe and fitting assemblies shall withstand for 1 minute, without rupture, separation, or leakage, an internal hydrostatic pressure of five times the rated pressure.

*Exception No. 1: The minimum test pressure and test period is allowed to be reduced for piping that has demonstrated by test an ability to absorb and reduce pressure surges in a system as compared to steel piping. The test pressure and test period reduction is to be determined based on the amount of pressure reduction as compared to steel pipe when tested in accordance with [24.4](#) and [24.5](#).*

*Exception No. 2: Pipe and fitting assemblies that include flanges shall withstand for 1 minute, without leakage, an internal hydrostatic pressure of two times the rated pressure. Flange gaskets and seals shall then be permitted to be replaced with a material and construction capable of withstanding the five times the rated pressure and the test described in [24.1](#) shall then be conducted without rupture or separation of the assembly.*

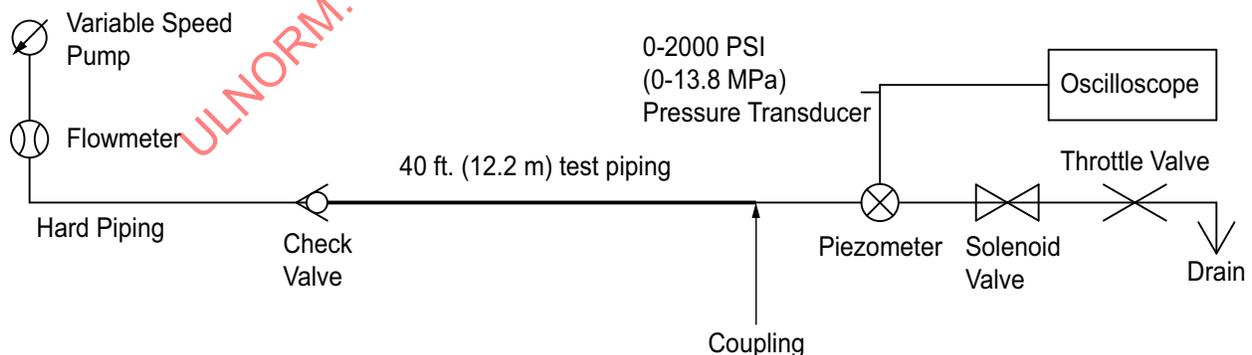
24.2 The assembly of the pipe and fittings shall be in accordance with the installation and design manual. For flexible piping products, samples are to be bent to the minimum bending radius specified in the installation and design manual.

24.3 The length of exposed pipe between fittings is to have a minimum length of ten times the diameter of the pipe.

*Exception: Shorter pipe lengths are allowed to be used when testing fitting assemblies.*

24.4 Representative sizes of pipe, at least 40 ft (12.2 m) in length shall be connected to a water flow apparatus consisting of a check valve, fast closing solenoid valve, throttling valve, piezometer, pressure transducer and oscilloscope and arranged as shown in [Figure 24.1](#). The system shall be capable of water flow velocities of at least 18 ft/s (5.5 m/s). Pressure transducers with an acquisition time of not more than 0.001s and a data acquisition system capable of reading the peak pressure values generated shall be used.

**Figure 24.1**  
**Water flow apparatus**



24.5 Pressure transients are to be generated in the apparatus by abruptly closing the fast closing (solenoid) valve while flowing water at a velocity at least 18 ft./s (5.5 m/s) with the test piping in place and then repeated with the test piping replaced with Schedule 40 steel piping of the same nominal size.

## 25 Pressure Cycling Test

25.1 Representative pipe and fitting assemblies shall withstand without leakage, separation, or rupture 3000 pressure cycles from zero to twice the rated pressure of the pipe and fittings. After the cycling, the pipe and fitting assemblies shall comply with the Leakage and Hydrostatic Pressure Test, Section [24](#).

25.2 The assembly of the pipe and fittings shall be in accordance with the installation and design manual. For flexible piping products, samples are to be bent to the minimum bending radius specified in the installation and design manual.

25.3 The pipe and fitting assemblies are to be connected to a pressure cycling apparatus, filled with water, and vented of all air. The internal pressure is to be cycled 3000 times from zero to twice the rated pressure to 0 psig (0 kPa) at an approximate rate of 10 cycles per minute.

25.4 The length of exposed pipe between fittings is to have a minimum length of ten times the diameter of the pipe.

*Exception: Shorter pipe lengths are allowed to be used when testing fitting assemblies.*

## 26 Temperature Cycling Test

26.1 Representative pipe and fitting assemblies shall comply with the Leakage and Hydrostatic Pressure Test, Section [24](#), after being subjected to temperature cycling from 35° F (1.7° C) to the maximum rated temperature.

26.2 The assembly of the pipe and fittings shall be in accordance with the installation and design manual. For flexible piping products, samples are to be bent to the minimum bending radius specified in the installation and design manual.

26.3 The pipe and fitting assemblies are to be filled with water, vented of air, hydrostatically pressurized to 50 psig (345 kPa), and subjected to temperature cycles of 35° F (1.7° C) to the maximum rated temperature to 35° F. Each assembly is to be held at each temperature specified for a period of 24 hours. A total of 5 complete cycles are to be completed.

26.4 The length of exposed pipe between fittings is to have a minimum length of ten times the diameter of the pipe.

*Exception: Shorter pipe lengths are allowed to be used when testing fitting assemblies.*

## 27 10-Day Moist Ammonia Air Stress Cracking Test

27.1 After being subjected to the conditions described in [27.2](#) – [27.4](#), 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.*

27.2 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 27.1](#). Teflon tape or pipe compounds are not to be used on the threads.

**Table 27.1**  
**Torque requirements for threaded connections**

Nominal pipe size (NPS)	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)

27.3 Three samples 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  $12 \pm 1$  by  $12 \pm 1$  by  $12 \pm 1$  inches ( $304.8 \pm 25.4$  by  $304.8 \pm 25.4$  by  $304.8 \pm 25.4$  mm) having a glass cover.

27.4 20.3 fl. oz. (600 ml) of 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  $93 \pm 2^\circ\text{F}$  ( $34 \pm 1^\circ\text{C}$ ).

## 28 Long-Term Hydrostatic Pressure Test

28.1 When tested as described in [28.3](#), pipe and fitting materials other than CPVC and crosslinked polyethylene described in [Table 28.1](#) shall demonstrate a hydrostatic design stress equal to or greater than the hoop stress applied to the pipe and fittings at the rated pressure and at the maximum rated temperature.

28.2 When tested as described in [28.4](#) and [28.5](#), CPVC and crosslinked polyethylene pipe and fitting assemblies shall withstand without rupture, leakage, or joint separation the hoop stress specified in [Table 28.1](#) applied to the assembly for 1000 hours at the maximum rated temperature.

28.3 The long-term hydrostatic strength of pipe and fittings including the method of joining pipe and fittings is to be determined by conducting testing in accordance with the Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure, ASTM D1598, in a controlled temperature water or air bath; and by analyzing the test results in accordance with the Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products, ASTM D2837. The hydrostatic design stress for the pipe is to be determined based on the long-term hydrostatic strength at 100,000 hours with a service factor of 0.5. In addition, the long-term hydrostatic strength at 50 years shall not be less than 90 percent of the long-term hydrostatic strength at 100,000 hours. The manufacturer shall provide data demonstrating compliance with the requirements. Sample pipe and fittings from each manufacturing facility are to be assembled in accordance with the installation and design manual. The assemblies are to be conditioned prior to testing to provide for curing of the joints as specified by the manufacturer.