UL 199

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Automatic Sprinklers for Fire-Protection Service

Underwriters Laboratories Inc. (UL)
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UL Standard for Safety for Automatic Sprinklers for Fire-Protection Service, UL 199

Tenth Edition, Dated April 8, 1997

Revisions: This Standard contains revisions through and including April 7, 2004.

Summary of Topics

These revisions to ANSI/UL 199 are being issued to change the effective date for the glass bulb sprinkler protective cover requirements.

UL Standards for Safety are developed and maintained in the Standard Generalized Markup Language (SGML). SGML -- an international standard (ISO 8879-1986) -- is a descriptive markup language that describes a document's structure and purpose, rather than its physical appearance on a page. Due to formatting differences resulting from the use of UL's new electronic publishing system, please note that additional pages (on which no requirements have been changed) may be included in revision pages due to relocation of existing text and reformatting of the Standard.

Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The following table lists the future effective dates with the corresponding reference.

Future Effective Dates	References
March 26, 2004	Paragraph 5.1.1 and Sections 14A, 20
September 26, 2004	Section 9A, 27A, 53A and paragraphs 52.1 and 54.20
June 8, 2005	Paragraphs 19.2.1, 19.2.2, 19.2.4, 19.2.5, 19.2.6, 54.2 and 54.19, and Tables 19.1 and 19.2

The revised effective dates are substantially in accordance with UL's Bulletin(s) on this subject dated March 5, 2004. The bulletin(s) is now obsolete and may be discarded.

The revisions dated April 7, 2004 include a reprinted title page (page1) for this Standard.

The revisions dated May 12, 1997 were issued to correct the effective date for paragraph 55.1.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: http://ulstandardsinfonet.ul.com/ulforeword.html

The master for this Standard at UL's Northbrook Office is the official document insofar as it relates to a UL service and the compliance of a product with respect to the requirements for that product and service, or if there are questions regarding the accuracy of this Standard.

The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

This Standard consists of pages dated as shown in the following checklist:

Page	Date
1-2B	April 7, 2004
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37-38	March 26, 2003
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UL 199

Standard for Automatic Sprinklers for Fire-Protection Service

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Tenth Edition

April 8, 1997

The most recent designation of ANSI/UL 199 as an American National Standard (ANSI) occurred on October 31, 2003.

This ANSI/UL Standard for Safety, which consists of the Tenth edition with revisions through April 7, 2004 is under continuous maintenance, whereby each revision is ANSI approved upon publication. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Written comments are to be sent to UL-RTP Standards Department, 12 Laboratory Dr., P.O. Box 13995, Research Triangle Park, NC 27709-3995.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

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INTRODUCTION

1 Scope

1.1 These requirements cover automatic sprinklers intended for installation on sprinkler systems for fire-protection service. Requirements for the installation and use of sprinklers are included in the Standard for the Installation of Sprinkler Systems, NFPA 13.

1.2 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

1.2 revised September 6, 2000

2 General

2.1 Sprinklers are categorized by operating temperature rating, nominal “K” factor, installation position, type of coating or plating, and other factors that have a bearing on their application.

2.1 revised January 24, 2000

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

2.2 revised September 6, 2000

2.3 Where these requirements reference ″extended coverage sprinklers″, the requirements apply to both extended coverage light hazard and extended coverage ordinary hazard sprinklers unless otherwise specified.

3 Glossary

3.1 General

3.1.1 For the purpose of this standard the following definitions apply:

3.2 Basic definitions

3.2.1 DISCHARGE COEFFICIENT ″K″ – Coefficient of discharge in the formula,

$$Q=K\sqrt{p}$$

in which:

Q is the flow in gallons per minute (L/s x 15.85), and

p is the pressure in pounds per square inch gauge (psig) (MPa x 145).

3.2.2 HEAT RESPONSIVE ELEMENT – That portion of a sprinkler that breaks, melts, or otherwise functions to initiate the automatic operation of the sprinkler when exposed to sufficient heat.

3.2.3 OPERATING TEMPERATURE – The temperature at which the heat responsive element of a sprinkler operates when subjected to a 1°F (0.5°C) per minute temperature rise while immersed in a liquid bath.

3.2.4 ORIFICE – The opening that controls the amount of water discharged from a sprinkler at a given pressure.

3.2.5 AUTOMATIC SPRINKLER – A sprinkler intended to open automatically by operation of a heat-responsive element that maintains the discharge orifice closed by means such as the exertion of pressure on a cap (button or disc). A sprinkler is installed on piping so that a spray of water is discharged in a specific pattern for suppression or control of fires.

3.3 Sprinkler type definitions

3.3.1 EXTENDED COVERAGE SPRINKLER INTENDED FOR LIGHT HAZARD OCCUPANCIES – A sprinkler intended:

a) For use at greater than standard spacing;

b) To open automatically by operation of a heat responsive element and releasing mechanism having a response time equal to or less than a standard response sprinkler used on standard spacings;

c) To discharge water over a specified coverage area at a specified minimum water flow rate; and

d) For use in light hazard occupancies as described in NFPA 13, Standard for Installation of Sprinklers. The use limitation for this sprinkler specifies the coverage area dimensions, minimum operating water flow rate, ″K″ factor, the type of ceiling configuration under which the sprinkler is intended to be installed, and installation position from the wall and ceiling, when different from NFPA 13.

3.3.1 revised January 24, 2000

3.3.2 EXTENDED COVERAGE SPRINKLER INTENDED FOR ORDINARY HAZARD OCCUPANCIES – A sprinkler intended:

a) For use at greater than standard spacing;

b) To open automatically by operation of a heat responsive element and releasing mechanism having a response time equal to or less than a standard response sprinkler used on standard spacings;

c) To discharge water over a specified coverage area at a specified minimum water flow rate; and

d) For use in ordinary hazard occupancies as described in NFPA 13, Standard for Installation of Sprinklers.

The use limitation for this sprinkler specifies the coverage area dimensions, minimum operating water flow rate, ″K″ factor, the type of ceiling configuration under which the sprinkler is intended to be installed, and installation position from the wall and ceiling, when different from NFPA 13.

3.3.2 revised January 24, 2000

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3.3.3 FLUSH CEILING SPRINKLER – A sprinkler in which only a minimum of the parts project below the ceiling.

3.3.4 COATED, PAINTED, OR PLATED SPRINKLER – A sprinkler that has factory applied coatings, paint, or platings for corrosion protection or decorative purposes.

3.3.5 CONCEALED CEILING SPRINKLER – A recessed sprinkler assembly having a cover plate installed approximately flush with the ceiling material for aesthetic purposes.

3.3.6 DRY-TYPE SPRINKLER – A sprinkler secured in an extension nipple that has a seal at the inlet end to prevent water from entering the nipple until the sprinkler operates. These sprinklers consist of an upright, pendent, sidewall, flush, or other types.

3.3.6 revised July 9, 2001

3.3.7 CONVENTIONAL (OLD STYLE) SPRINKLER – A sprinkler intended for installation in the upright or pendent position, that directs from 40 to 60 percent of the total water initially discharged in the downward direction. When installed in the upright position, this discharge covers a 10 foot (3.05 m) diameter circle, 10 feet (3.05 m) below the sprinkler, when the sprinkler is discharging water at the rate of 15 gallons per minute (0.95 L/s). See Water Distribution Test – Conventional (Old Style) Sprinklers, Section 32.

3.3.8 FLOW CONTROL (FC) SPRINKLER – A sprinkler that is intended to control water flow by automatically cycling open and closed within a specified temperature range.

3.3.9 A HIGH TEMPERATURE, WAX COATED SPRINKLER – A sprinkler intended to be installed where corrosion resistant, high temperature rated sprinklers are required and where the maximum ambient temperature does not exceed 150°F.

3.3.10 OPEN SPRINKLER – An automatic sprinkler with the heat responsive and activating elements removed. The discharge orifice is open.

3.3.11 PENDENT SPRINKLER – A sprinkler intended to be installed so that its deflector is located below the orifice and the water flows downward through the orifice.

3.3.12 QUICK RESPONSE (QR) SPRINKLER – A sprinkler that complies with the applicable requirements for such sprinklers in the Sensitivity Tests, Section 19, and that is intended to be installed at standard spacings.

3.3.13 QUICK RESPONSE-EXTENDED COVERAGE LIGHT HAZARD OCCUPANCY SPRINKLER – A sprinkler that complies with the applicable requirements for such sprinklers in the Sensitivity Tests, Section 19, when tested and installed in a test room at greater than standard spacings as stated in the installation instructions and complies with the requirements for extended coverage light hazard occupancy sprinklers.

3.3.14 QUICK RESPONSE-EXTENDED COVERAGE ORDINARY HAZARD OCCUPANCY SPRINKLER – A sprinkler that complies with the applicable requirements for such sprinklers in the Sensitivity Tests, Section 19, when tested and installed in a test room at greater than standard spacings as stated in the installation instructions and complies with the requirements for extended coverage ordinary hazard occupancy sprinklers.

3.3.15 RECESSED SPRINKLER – A sprinkler assembly in which all or part of the sprinkler body or frame, other than the shank thread, is mounted within a housing that is recessed within a wall or ceiling.

3.3.16 SIDEWALL SPRAY SPRINKLER – A sprinkler intended for installation on or near the wall and near the ceiling, and intended to discharge water onto the walls and outward in a quarter-spherical pattern.

3.3.17 SPRAY SPRINKLER – A sprinkler intended for installation in either the upright or pendent position respectively, designed to distribute water downward in an umbrella-shaped pattern. The discharge from a spray sprinkler having a nominal 5.6 “K” factor covers a circle 16 feet (4.88 m) in diameter, 4 feet (1.22 m) below the sprinkler, when the sprinkler is discharging water at the rate of 15 gallons per minute (0.95 L/s). See 10 Pan Distribution Test, Section 30.

3.3.17 revised January 24, 2000

3.3.18 UPRIGHT SPRINKLER – A sprinkler intended to be installed so that its deflector is located above the orifice and the water flows upward through the orifice.

4 Components

4.1 Except as indicated in 4.2, a component of a product covered by this standard shall comply with the requirements for that component.

4.2 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.

4.2 revised September 6, 2000

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

4.3 revised September 6, 2000

4.4 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.

4.4 revised September 6, 2000

CONSTRUCTION

5 General

5.1 An automatic sprinkler shall be constructed to effect closure of its water seat for extended periods of time without leakage and to open as intended and release all parts at a pressure of 5 psi (0.034 MPa) up to the rated pressure. The closure of the water seat shall not be achieved by the use of a dynamic O-ring or similar seal (an O-ring or similar seal that moves during operation or is in contact with a component that moves during operation).

5.1 revised March 26, 2003

5.1.1 For dry-type pendent and sidewall sprinklers, the connection of the extension nipple to the seal assembly at the inlet shall be airtight. See Section 14A, Dry Sprinkler Air Tightness Test.

Added 5.1.1 effective March 26, 2004

5.2 Stampings shall show no cracking or splitting and shall be uniformly smooth and clean cut.

5.3 An automatic sprinkler shall be chemically or mechanically staked to maintain the manufacturer's assembly load. The assembly load shall not be able to be changed by the use of common hand tools without causing visible damage to the sprinkler.

5.4 Sprinkler types or materials not anticipated by these requirements require additional evaluation, such as tests to investigate special metallic or nonmetallic materials.

5.5 When installed with the intended fittings specified in the installation instructions (see Section 55, Design Parameters and Installation Instructions), dry sprinklers installed in dry systems shall be constructed to minimize the potential to accumulate water, scale, and sediment on the sprinkler inlet and shall provide an unobstructed flow path upon operation.

5.5 effective October 8, 1998

6 Inlet Threads

6.1 Sprinklers shall be provided with external pipe threads at the inlet end as specified in Table 8.1. Inlet-end pipe threads shall comply with the Standard for Pipe Threads, General Purpose (Inch) (Revision and Redesignation of ASME/ANSI B2.1-1968)(R1992), ASME B1.20.1-1983.

Exception No. 1: Ceiling- and dry-type sprinklers shall be permitted to be provided with 3/4- or 1-inch external NPT pipe threads.

Exception No. 2: Internal taper pipe threads (NPT) of 3/4- or 1-inch size shall be permitted to be used for an 8.0 nominal "K" factor, ceiling type, and dry type sprinklers in lieu of those specified in Table 8.1.

Exception No. 3: Sprinklers intended for use in installations where sprinkler 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.

Exception No. 4: Sprinkler inlets intended for attachment to piping by means other than threads are able to be used when the sprinklers:

a) Have a nominal "K" factor corresponding to the discharge coefficient as specified in Table 8.1;

b) Are provided with nominal "K" factor markings as specified in 54.2; and

c) Are intended to be attached in a manner that does not involve welding and that permits sprinkler removal from sprinkler piping without the use of special tools or torch cutting equipment.

6.1 revised January 24, 2000

6.2 Threads shall be clean cut and true and free from burrs, scoring or chatter marks.

7 Temperature Ratings

7.1 The temperature ratings and temperature classifications of automatic sprinklers shall be as specified in Table 7.1. The frame arms of automatic sprinklers or frangible bulb heat responsive elements shall be colored according to the color code specified in Table 7.1. See 54.9.

7.1 revised March 26, 2003

Table 7.1
Temperature classification ratings and color coding

Table 7.1 revised March 26, 2003

Temperature classification	Temperature rating		Color code		Maximum ceiling temperature	
	Degrees F	(Degrees C)	Frame arms	Frangible bulb	Degrees F	(Degrees C)
Ordinary	135 – 170	(57 – 77)	Uncolored or black	Orange or red	100	(38)
Intermediate	175 – 225	(79 – 107)	White	Yellow or green	150	(66)
High	250 – 300	(121 – 149)	Blue	Blue	225	(107)
Extra high	325 – 375	(163 – 191)	Red	Purple	300	(149)
Very extra high	400 – 475	(204 – 246)	Green	Black	375	(191)
Ultra high	500 – 575	(260 – 302)	Orange	Black	475	(246)

7A Pressure Rating

7A.1 Sprinklers shall have a rated pressure of 175 psig (1.2 Mpa), 250 psig (1.7 Mpa), or 300 psig (2.1 Mpa).

7A.1 added October 8, 1997

8 Nominal “K” Factor

8.1 A sprinkler shall have a discharge coefficient complying with one of the nominal “K” factor ranges specified in Table 8.1. The nominal “K” factor is to be determined from the discharge coefficient “K”, as specified by the Calibration Test, Section 29.

8.1 revised January 24, 2000

Table 8.1
Nominal “K” factor and Thread Size

Table 8.1 revised January 24, 2000

Nominal K	Discharge coefficient ″K″	External thread-type
1.4	1.3 – 1.5	1/2 inch NPT
1.9	1.8 – 2.0	1/2 inch NPT
2.8	2.6 – 2.9	1/2 inch NPT
4.2	4.0 – 4.4	1/2 inch NPT
5.6	5.3 – 5.8	1/2 inch NPT
8.0	7.4 – 8.2	3/4 inch NPT or 1/2 inch NPT
11.2	11.0 – 11.5	3/4 inch NPT or 1/2 inch NPT
14.0	13.5 – 14.5	3/4 inch NPT

8.2 Sprinkler orifices shall have individual ″K″ factor values that are within ±5 percent of the average ″K″ factor determined at a specific pressure for the dimensional tolerance specified by the manufacturer.

8.2 revised January 24, 2000

8.3 The diameter of a discharge orifice or any internal passage of a sprinkler shall be at least 0.21 inch (5.3 mm).

9 Coatings And Platings

9.1 The operation and distribution characteristics of a sprinkler shall not be impaired by the application of any factory applied coating, paint, or plating when the sprinkler is tested in accordance with these requirements.

9.2 A corrosion resistant coating or plating shall be uniformly applied.

9.3 A wax coating shall not be brittle when new nor become brittle with age.

9A Protective Covers

9A.1 Sprinklers with frangible bulb type heat responsive elements shall be equipped with protective covers that are designed to remain in place during installation and be removed before the sprinkler system is placed in service.

Exception: Certain sprinkler designs, such as concealed sprinklers and sprinklers with guards, may not be required to have protective covers.

9A.1 effective September 26, 2004 for sprinklers with a glass bulb having a diameter of greater than 4 mm

9A.2 Sprinklers required to be equipped with sprinkler covers shall comply with Section 27A, Impact Test for Protective Covers, and 54.20.

9A.2 effective September 26, 2004 for sprinklers with a glass bulb having a diameter of greater than 4 mm

PERFORMANCE

10 General

10.1 To determine compliance with these requirements, the various types and patterns of a sprinkler shall be subjected to the performance tests described in Sections 12 – 51, and specified in Table 10.1.

10.2 When a recessed or concealed sprinkler is tested with an escutcheon during the performance tests, the sprinkler is to be recessed to the maximum depth allowed by the sprinkler/escutcheon combination.

Table 10.1
Sprinkler test requirements

Table 10.1 revised March 26, 2003

Section number and test	Basic sprinkler types, lowest temperature rating			Variations to basic sprinkler types				Other sprinkler types[a]						
	Spray upright/ pendent	Old style	Flow control	Each addi-tional temper-ature rating	Each addi-tional orifice size	Decora-tive coatings or platings	Corrosion resistant coatings or platings	Dry	Ceiling	Side-wall	EC light hazard	EC ordinary hazard	Quick response	Other[b]
12. Load on heat responsive element	X	X	X	–	X	–	–	X	–	–	–	–	X	–
13. Strength of heat responsive element	X	X	X	–	X	–	–	X	–	–	–	–	X	–
14. Leakage	X	X	X	–	X	X	X	X	–	–	–	–	X	–
14A. Dry sprinkler air tightness	–	–	–	–	–	–	–	X	–	–	–	–	–	–
15. Hydrostatic strength	X	X	X	–	X	–	–	X	–	–	–	–	X	–
16. 30-day leakage	X	X	X	–	X	–	–	X	–	–	–	–	X	–
17. Water hammer	X	X	X	–	X	–	–	X	–	–	–	–	X	–
18. Operating temperature (bath)	X	X	X	X	–	X	X	–	–	–	–	–	X	–
19. Sensitivity	X	X	X	X	–	X	X	–	–	–	–	–	X	–
20. Operation – lodgement	X	X	X	–	X	–	X	X	X	X	X	X	X	–
21. Flow endurance	X	X	X	–	X	–	–	–	–	X	X	X	–	–
22. Operation – cold soldering	X	–	X	–	X	–	–	–	–	X	X	X	X	–
23. High temperature– test for uncoated sprinklers	X	X	X	X	–	X	–	X	X	–	–	–	X	–
24. High temperature – test for coated sprinklers	–	–	–	–	–	–	X	–	–	–	–	–	–	–
25. Strength of frame	X	X	X	–	X	–	–	X	–	–	–	–	X	–
26. Impact resistance	X	X	X	–	–	–	–	–	–	–	–	–	X	–
27. Rough usage	X	X	X	–	–	–	–	–	–	–	–	–	X	–

Table 10.1 Continued on Next Page

Table 10.1 Continued

Section number and test	Basic sprinkler types, lowest temperature rating			Variations to basic sprinkler types				Other sprinkler types[a]						
	Spray upright/ pendent	Old style	Flow control	Each addi-tional temper-ature rating	Each addi-tional orifice size	Decora-tive coatings or platings	Corrosion resistant coatings or platings	Dry	Ceiling	Side-wall	EC light hazard	EC ordinary hazard	Quick response	Other[b]
27A. Impact test for protective covers	–	–	–	–	–	–	–	–	–	–	–	–	–	X
28. Vibration	X	X	X	–	–	–	–	X	X	–	–	–	X	–
29. Calibration	X	X	X	–	X	–	–	X	–	–	–	–	–	–
30. 10 pan distribution	X	–	X	–	X	–	–	X	X	–	–	–	–	–
31. 16 pan distribution	X	–	X	–	X	–	–	X	X	–	–	–	–	–
32. Water Distribution – conventional (old style) sprinklers	–	X	–	–	–	–	–	–	–	–	–	–	–	–
33. 100 pan distribution – sidewall sprinklers	–	–	–	–	–	–	–	–	–	X	–	–	–	–
34. 350 Pound wood crib fire	X	–	X	–	X	–	–	X	X	X[c]	–	–	–	–
35. 10 day corrosion	X	X	X	–	–	–	–	X	X	–	–	–	X	–
36. 30 day corrosion	–	–	–	–	–	–	X	–	–	–	–	–	–	X
37. 90 day moist air	X	X	X	–	–	X	–	X	–	–	–	–	X	X
38. Stress-corrosion cracking of brass parts	X	X	X	–	–	–	–	–	–	X	X	–	X	–
39. Stress-corrosion cracking of stainless steel parts	X	X	X	–	–	–	X	–	–	–	–	–	X	X
40. Operational tests on sprinklers incorporating gaskets or ″O″ ring seals	–	–	X	–	–	–	–	–	–	–	–	–	–	X

Table 10.1 Continued on Next Page

Table 10.1 Continued

Section number and test	Basic sprinkler types, lowest temperature rating			Variations to basic sprinkler types				Other sprinkler types[a]						
	Spray upright/ pendent	Old style	Flow control	Each addi-tional temper-ature rating	Each addi-tional orifice size	Decora-tive coatings or platings	Corrosion resistant coatings or platings	Dry	Ceiling	Side-wall	EC light hazard	EC ordinary hazard	Quick response	Other[b]
40A. Dry-type sprinkler deposit loading	–	–	–	–	–	–	–	X	–	–	–	–	–	–
40B. Dezincification test of brass parts	X	X	X	–	–	–	–	–	–	–	–	–	–	–
41. Vacuum test	X	X	X	–	X	–	–	–	–	–	–	–	–	–
42. Elastomeric parts test	X	X	X	–	–	–	–	–	–	–	–	–	–	X
43. Freezing test	X	X	X	–	X	–	–	–	–	–	–	–	–	–
44. Fire test for EC sprinklers	–	–	–	–	–	–	–	–	–	–	X	–	–	–
45. Wall wetting test for EC sprinklers	–	–	–	–	–	–	–	–	–	–	X	–	–	–
46. Evaporation test for sprinkler coatings	–	–	–	–	–	–	X	–	–	–	–	–	–	–
47. Cycling tests for FC sprinklers	–	–	X	–	–	–	–	–	–	–	–	–	–	–
48. Piled stock fire test for FC sprinklers	–	–	X	–	–	–	–	–	–	–	–	–	–	–
49. Piled stock fire test for ECOH sprinklers	–	–	–	–	–	–	–	–	–	–	–	X	–	–
50. Distribution test for ECOH sprinklers	–	–	–	–	–	–	–	–	–	–	–	X	–	–
51. High temperature exposure test for FC sprinklers	–	–	X	–	–	–	–	–	–	–	–	–	–	–
53A. Frangible bulb integrity	–	–	–	–	–	–	–	–	–	–	–	–	–	X[d,e]

NOTE – This table is intended only as a guide to determining which tests are applicable to sprinkler types, and variations of sprinkler types. Other sprinkler types or materials not anticipated by these requirements may require additional tests, such as tests to evaluate and identify special metallic or nonmetallic materials. An ″X″ indicates a required test.

Table 10.1 Continued on Next Page

Table 10.1 Continued

Section number and test	Basic sprinkler types, lowest temperature rating			Variations to basic sprinkler types				Other sprinkler types[a]						
	Spray upright/ pendent	Old style	Flow control	Each addi-tional temper-ature rating	Each addi-tional orifice size	Decora-tive coatings or platings	Corrosion resistant coatings or platings	Dry	Ceiling	Side-wall	EC light hazard	EC ordinary hazard	Quick response	Other[b]

[a] An other sprinkler type is also identified as a basic sprinkler type when the sprinkler meets the definition of a standard, conventional (old style), or flow control sprinkler. In such cases, the sprinkler shall also comply with the tests specified in the ″Basic Sprinkler Types, Lowest Temperature Rating″ column of this table. The ″additional″ tests specified under the ″Other Sprinkler Types″, column apply to sprinklers that have components or installation techniques not evaluated during ″basic sprinkler type″ testing.

[b] Sprinklers having components of stainless steel or nonmetallic sealing materials.

[c] Not required for light and ordinary hazards occupancies.

[d] Sprinklers with frangible bulbs.

[e] Any sprinkler equipped with a protective cover.

11 Samples

11.1 The number of samples required for investigation varies for different sprinkler types. The number of samples required for examination and test are to be determined following a review of detailed drawings, examination of a preliminary sample, or both.

12 Load On Heat Responsive Element Test

12.1 The average and maximum design loads exerted on the heat responsive element, and the overall load tolerance based on the design load for the assembly, is to be determined. When the application of the rated working pressure to the inlet end of the sprinkler increases the assembly load by more than 10 percent, the additional load is to be added to the measured load on the heat responsive element. The information developed is to be used for Strength of Heat Responsive Element Test, Section 13.

12.2 At least 25 sprinklers are to be tested to determine the average load. An arrangement for measuring the load on the heat responsive element is to be developed for each specific design.

13 Strength Of Heat Responsive Element Test

13.1 Fusible-alloy types

13.1.1 A heat responsive element in the ordinary temperature rating shall either:

a) Sustain a load of 15 times its maximum design load for a period of 100 hours; or

b) Demonstrate the ability to sustain the maximum design load when tested in accordance with 13.1.2 and 13.1.3.

13.1.2 Compliance with 13.1.1(b) is to be determined by subjecting sample heat-responsive elements to loads in excess of the maximum design load. A minimum of ten samples are to be loaded at various values as required up to 15 times the design load. At least one heat responsive element shall sustain a load for a time greater than 1000 hours. These load and time values shall then be used to derive a least-square, full logarithmic regression curve of time as a function of load, from which the loads at 1 hour and 1000 hours are to be determined. The design load shall comply with the following equation:

$$L_d \leq 1.02\, L_m^2 / L_o$$

in which:

L_d *is the maximum design load,*

L_m *is the load at 1000 hours, and*

L_o *is the load at 1 hour.*

13.1.3 The test samples are to be loaded at a conditioned temperature of 70 ±5°F (21 ±3°C).

13.2 Frangible-bulb types

13.2.1 The lower tolerance limit for bulb strength, based on calculations with a degree of confidence of 0.99 for 99 percent of samples, shall exceed two times the upper tolerance limit for sprinkler assembly load based on calculations with the same degree of precision as for bulb strength. Calculations are to be based on the Normal or Gaussian Distribution except where another distribution is shown to be more applicable due to manufacturing or design factors. The bulb strength is to be measured by applying a steadily increasing load, utilizing a compression testing machine, until the bulb breaks. This test is to be conducted with the bulb mounted in the seating parts, with the same dimensions used in the sprinkler and a material hardness within the range of 38 – 50 Rockwell C. The rate of loading shall not exceed 55 pounds-force load per second (25 kg/s), or at a rate that deflects the bulb 0.02 inch (0.51 mm) per minute, whichever measurement is convenient for the test apparatus being used. Bulb seatings shall be permitted to be reinforced circumferentially so as not to interfere with the bulb breakage. A minimum of 15 samples of each temperature rating and each bulb type are to be tested. See Appendix A.

13.2.1 revised January 24, 2000

13.2.2 A sprinkler having a frangible bulb shall withstand the thermal shock of rapid temperature changes 20°F (11°C) below its marked operating temperature or 20°F below the lowest allowable value of the operating temperature range determined in the Operating Temperature (Bath) Test, Section 18, whichever is lower. At least five samples of the sprinkler are to be conditioned for 5 minutes in a liquid bath at 20°F less than their rated operating temperature or minimum permitted operating temperature. The samples then are to be removed and immediately submerged in another liquid bath at 50°F (10°C). There shall be no breakage or fracture of the frangible bulb.

13.2.2 revised March 26, 2003

14 Leakage Test

14.1 When tested as described in 14.2 and 14.3, an automatic sprinkler shall not exhibit leakage at any pressure from 0 to the applicable leakage test pressure shown in Table 14.1.

14.1 revised October 8, 1997

Table 14.1
Test pressures for the leakage and hydrostatic tests

Table 14.1 added October 8, 1997

Rated pressure		Leakage test pressure		Hydrostatic test pressure	
psig	(MPa)	psig	(MPa)	psig	(MPa)
175	(1.2)	500	(3.4)	700	(4.8)
250	(1.7)	500	(3.4)	1000	(6.9)
300	(2.1)	600	(4.1)	1200	(8.3)

14.2 At least 20 samples are to be individually tested. The sprinkler inlets are to be filled with water and vented of air.

14.3 The pressure is to be increased from 0 to the test pressure at a rate not exceeding 300 psig (2.07 MPa) per minute and then held for 1 minute. There shall be no visible leakage in any sample.

14.3 revised October 8, 1997

14A Dry Sprinkler Air Tightness Test

14A.1 When tested as described in 14A.2 and 14A.3, the connection of the extension nipple to the inlet seal assembly for a dry-type pendent or sidewall sprinkler shall not exhibit leakage at any air pressure from 0 to 15 psig (0 to 103 kPa) when the pressure is applied externally to this connection.

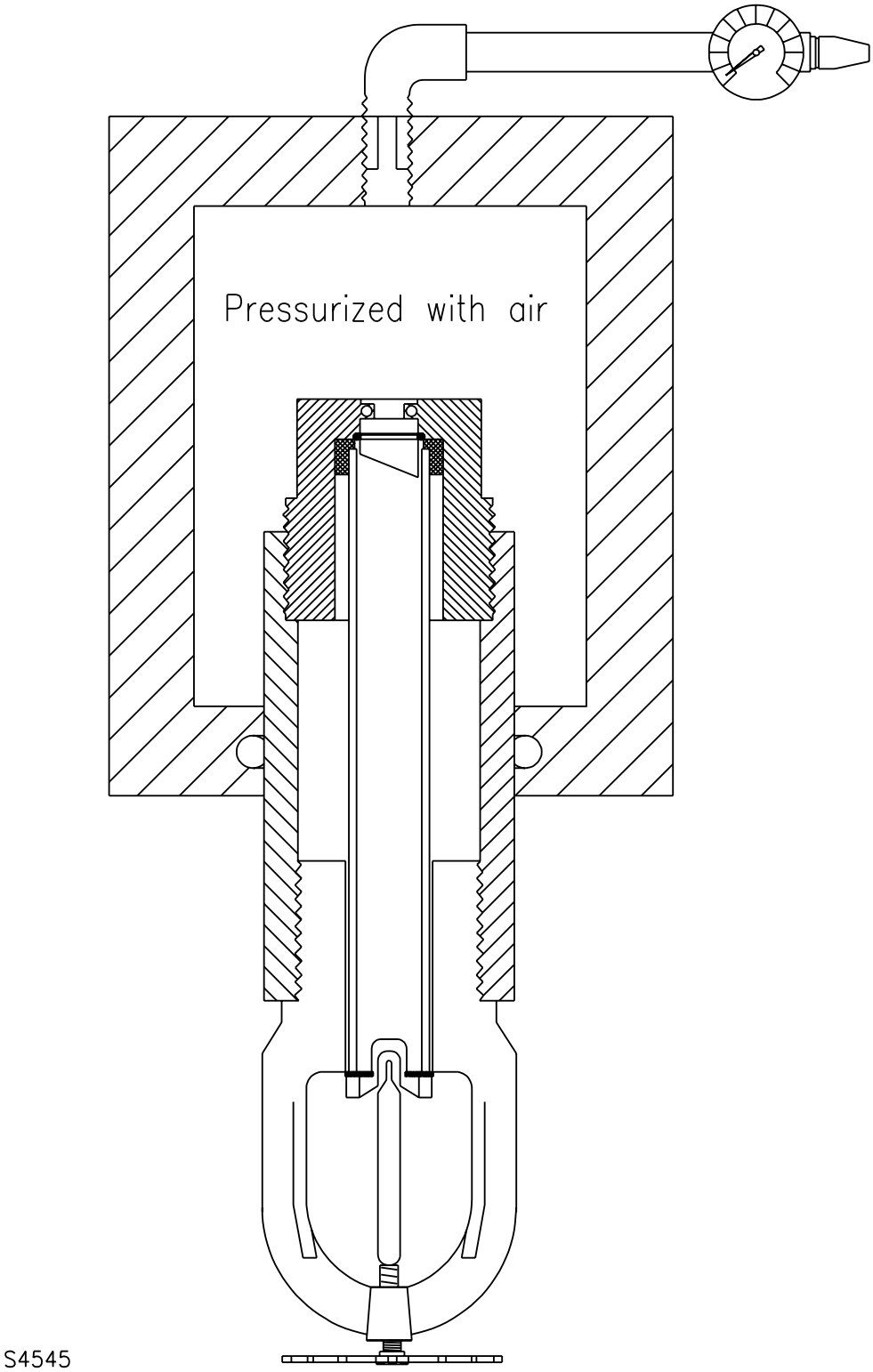
Added 14A.1 effective March 26, 2004

14A.2 At least five samples are to be individually tested. The assembly is to be installed in an air leakage test fixture in such a manner that the extension nipple connection to the inlet seal assembly can be fully pressurized with air. See Figure 14A.1.

Added 14A.2 effective March 26, 2004

Figure 14A.1
Dry sprinkler air tightness test apparatus (typical)

Added Figure 14A.1 effective March 26, 2004



14A.3 The assembly is to be immersed in water and orientated so that air bubbles indicating leakage past the extension nipple and inlet seal assembly connection point are allowed to freely escape from internal waterway of the dry sprinkler assembly. The air pressure applied to the connection point is then to be increased from 0 to 15 psig (0 to 103 kPa) within 30 seconds and then held for 30 seconds. Observations shall be made for leakage as evidenced by any air bubbles escaping from the internal portion of the dry sprinkler assembly.

Added 14A.3 effective March 26, 2004

15 Hydrostatic Strength Test

15.1 An automatic sprinkler shall withstand, for 1 minute, without rupture, an internal hydrostatic pressure equal to the hydrostatic test pressure shown in Table 14.1.

15.1 revised October 8, 1997

15.2 At least 20 samples are to be individually tested. The sprinkler inlets are to be filled with water and vented of air. The pressure is to be increased from 0 to the hydrostatic test pressure shown in Table 14.1 at a rate not exceeding 300 psig (2.07 MPa) per minute. The pressure is to be maintained at the test pressure and held for 1 minute. The sample shall not rupture, operate, or release any of its operating parts during the pressure increase nor while being maintained at the test pressure for 1 minute.

15.2 revised October 8, 1997

No Text on This Page

16 30-Day Leakage Test

16.1 When tested as described in 16.2 – 16.4, an automatic sprinkler shall:

a) Experience no leakage when subjected to the 30 day test pressure specified in Table 16.1 for 30 days;

b) Not leak when subjected to the leakage test pressure specified in Table 14.1 or less for 1 minute following the 30 days; and

c) Show no distortion or other mechanical damage following the leakage testing, as determined by visual examination.

16.1 revised October 8, 1997

Table 16.1
Test pressures for the 30-day leakage test

Table 16.1 added October 8, 1997

Rated pressure		30-day test pressure	
psig	(MPa)	psig	(MPa)
175	(1.2)	300	(2.1)
250	(1.7)	450	(3.1)
300	(2.1)	500	(3.4)

16.2 Five samples are to be installed on a water-filled test line maintained under a constant test pressure as specified in Table 16.1 for 30 days. The samples are to be examined weekly during the test period for evidence of leakage of water at the closure cap.

16.2 revised October 8, 1997

16.3 Following completion of this 30-day test period, the samples are to be tested to verify that they do not leak at the leakage test pressure specified in Table 14.1 or at any lower pressure. The pressure is to be increased from 0 to the test pressure a rate not exceeding 300 psig (2.07 MPa) per minute. The pressure is to be maintained at the leakage test pressure specified in Table 14.1 for 1 minute, and is then to be decreased to 0 psig at a rate not exceeding 300 psig per minute.

16.3 revised October 8, 1997

16.4 The samples then are to be visually examined to verify there is no evidence of distortion or other mechanical damage.

17 Water Hammer Test

17.1 When tested as described in 17.2 – 17.5, an automatic sprinkler shall:

a) Experience no leakage when subjected to 3,000 applications of pressure surges having a test pressure range as specified in Table 17.1;

b) Not leak when subjected to the leakage test pressure specified in Table 14.1 for 1 minute, following the 3,000 cycles of water hammer; and

c) Show no distortion or other physical damage following the water hammer testing, as determined by visual examination.

17.1 revised October 8, 1997

Table 17.1
Test pressure ranges for the water hammer test

Table 17.1 added October 8, 1997

Rated pressure		Test pressure range	
psig	(MPa)	psig	(MPa)
175	(1.2)	50 – 500	(0.34 – 3.4)
250	(1.7)	50 – 500	(0.34 – 3.4)
300	(2.1)	150 – 600	(1 – 4.1)

17.2 Five samples are to be installed on a water-filled test line connecting with a small motor-operated piston pump that produces a rapid rise in discharge pressure in accordance with Table 17.1 at the rate of 60 cycles per minute. The test piping is to be filled so that there is water at the sprinkler seat, and the pump is to be placed in operation and adjusted to produce the specified test-pressure cycle.

17.2 revised October 8, 1997

17.3 During the pressure cycling, observations are to be made for evidence of leakage.

17.4 Following completion of the pressure cycling, the samples are to be tested to verify that they do not leak at the leakage test pressure specified in Table 14.1 or at any lower pressure. The pressure is to be increased from 0 to the required test pressure at a rate not exceeding 300 psig (2.07 MPa) per minute. The pressure is to be maintained at the leakage test pressure specified in Table 14.1 for 1 minute, and is then to be decreased to 0 psig at a rate not exceeding 300 psig per minute.

17.4 revised October 8, 1997

17.5 The samples then are to be visually examined to verify there is no evidence of distortion or other mechanical damage.

18 Operating Temperature (Bath) Test

18.1 The operating temperature of automatic sprinklers and cover plates, when tested as described in 18.1 – 18.7, shall be within a maximum temperature range as follows: 1) ±3.5 percent of the marked nominal temperature for sprinklers rated less than 400°F, and 2) 107 percent of the mark nominal temperature for sprinklers rated 400°F and higher. For the purpose of this determination for sprinklers rated 400°F and higher, the marked temperature rating is to be included as one of the values within the range, making a total of eleven values in the range. Upon operation, all operating parts of the sprinkler shall clear the waterway as intended.

18.1 revised March 26, 2003

18.1.1 Sprinkler operation for this test includes the intended functioning of eutectic elements or any rupture of a frangible bulb heat responsive element. If partial fracture of the frangible bulb in the liquid environment occurs which does not result in sprinkler operation, the temperature at which bulb-fracture occurred shall be considered the operating temperature.

18.1.1 added March 26, 2003

18.2 At least ten samples of each type of sprinkler produced, including plated, painted, coated, and uncoated types of each temperature rating are to be subjected to this test. A sprinkler that does not require pressure to operate is to be tested at zero gauge pressure. A sprinkler that requires pressure to operate is to be tested while pressurized at 4-1/2 ±1/2 psig (31 ±3.4 kPa).

18.3 The samples are to be placed in an upright position and completely immersed in the water or oil bath. The bath vessel is to be provided with a source for heating the liquid at the prescribed rate and with means to agitate the liquid and measure the temperature of the liquid bath.

18.4 Water is to be used in bath tests of sprinklers that have operating temperature ratings of 175°F (79°C) or lower. Samples having operating temperature ratings of 176 – 575°F (80 – 302°C) are to be bath-tested in an oil having a flash point exceeding the test temperature.

18.5 An agitator is to be used as an aid in obtaining uniformity in temperature of the liquid in the bath.

18.6 A laboratory mercury thermometer, calibrated in accordance with the Standard Specification for ASTM Thermometers (Method 9501 – Federal Test Method Standard No. 791b), E 1-95, is to be used to determine temperatures of the liquids in bath tests. The bulb of the thermometer is to be held level with the sprinkler operating parts by a support member.

18.7 The temperature of the bath liquid is to be increased at a convenient rate until the liquid is within 20°F (11°C) of the temperature rating of the device [30°F (16°C) for 325°F (163°C) and higher temperature ratings]. The rate of temperature rise then is to be controlled at a rate not exceeding 1°F (0.5°C) per minute until operation of the sprinkler or until a temperature 20°F above the rated temperature is reached. The temperature of the liquid and the time of operation, as each sprinkler operates, are to be recorded.

19 Sensitivity Tests

19.1 General

19.1.1 An automatic sprinkler, other than a dry-type, shall comply with the following requirements:

a) 19.2.2 for standard response sprinklers;

b) 19.3.1 for standard response ordinary and intermediate temperature rated ceiling type sprinklers;

c) 19.4.1 for standard response extended coverage sprinklers; or

d) 19.2.1 and 19.5.1 for QR and QR extended coverage sprinklers.

A sprinkler that complies with (a) and not (b) of 19.2.1 does not comply with this standard.

19.1.2 A coating shall not remain on sprinkler parts in a manner that impairs operation or distribution at the time of sprinkler operation in 19.2 and 19.5.

19.2 Sensitivity – oven heat test

19.2.1 A QR sprinkler shall have the following operating time characteristics when tested in the sensitivity test oven as specified in 19.2.3 – 19.2.5:

a) A maximum operating time specified in Table 19.1 for each sample sprinkler. If the sprinkler temperature rating is not shown in Table 19.1, the maximum operating time for each sample sprinkler shall be determined by using the formula specified in 19.2.6 based on a Response Time Index (RTI) value of 50 $(m \cdot s)^{1/2}$ [90 $(ft \cdot s)^{1/2}$], and the marked temperature rating of the sprinkler.

b) Mean operating time equal to or less than a 1.30 multiple of the mean operating time of the sprinkler tested in accordance with (a) after being subjected to the exposure tests specified in Sections 23, 26, 28, and 35.

Revised 19.2.1 effective June 8, 2005

19.2.2 A standard response sprinkler shall operate within the time range specified in Table 19.1 for each sample sprinkler when tested in the oven heat test as specified in 19.2.3 – 19.2.5. If the sprinkler temperature is not shown in Table 19.2, the minimum and maximum operating time range for each sample sprinkler shall be determined by using the formula specified in 19.2.6, based on a RTI value of 80 $(m \cdot s)^{1/2}$ [145 $(ft \cdot s)^{1/2}$] for the minimum value and on a RTI value of 350 $(m \cdot s)^{1/2}$ [630 $(ft \cdot s)^{1/2}$] for the maximum value, and the marked temperature rating of the sprinkler.

Exception: The minimum operating time for the oven sensitivity test does not apply to extended coverage and ceiling type sprinklers complying with 19.4 - 19.5.

Revised 19.2.2 effective June 8, 2005

Table 19.1
Operating time for sprinklers in sensitivity-oven heat test

Revised Table 19.1 effective June 8, 2005

Sprinkler temperature rating		Oven temperature		Quick response type, s	Standard response type, s		Coated standard response type, s [a]
°F	°C	°F	°C	Max.	Min.	Max.	Max.
135	57.2	275	135	11.2	17.8	78.0	180
140	60.0	275	135	12.3	19.7	86.1	180
155	68.3	275	135	16.0	25.6	111.9	180
160	71.1	275	135	17.4	27.7	121.3	180
165	73.9	275	135	18.8	30.0	131.1	180
175	79.4	386	197	12.1	19.4	84.8	180
200	93.3	386	197	16.1	25.7	112.4	180
212	100.0	386	197	18.2	29.0	127.1	180
220	104.4	386	197	19.6	31.8	137.3	180
250	121.1	555	291	14.3	22.7	99.3	180
286	141.1	555	291	18.1	29.0	126.8	180
300	148.9	555	291	19.8	31.7	138.5	180
360	182.2	765	407	16.7	26.8	117.0	180
400	204.4	765	407	20.0	32.0	139.9	180
450	232.2	765	407	24.6	39.4	172.3	180
500	260.0	765	407	30.0	48.1	210.3	210.3

[a] Corrosion resistant sprinklers with coated heat responsive elements including wax, lead, Teflon, wax over lead, and polyester coating. Coated quick response sprinklers shall comply with 19.2.1.

Table 19.2
Sensitivity Oven Temperatures

Added Table 19.2 effective June 8, 2005

Sprinkler temperature rating		Oven temperature	
°F	(°C)	°F ±2°F	(°C ±1°C)
135 – 170	(57 – 77)	275	(135)
175 – 225	(79 – 107)	386	(197)
250 – 300	(121 – 149)	555	(290)
325 – 375	(163 – 191)	765	(407)
400 – 475	(204 – 246)	765	(407)
500 – 575	(260 – 302)	765	(407)

19.2.3 Sprinklers of each style are to be tested in the sensitivity test oven in the pendent position with the heat responsive element located at least 1 inch (25.4 mm) away from the inside surfaces of the oven as follows:

a) For sprinkler designs without frame arms and incorporating symmetrical heat responsive elements and symmetrical sprinkler bodies, ten samples are to be orientated in the pendent position.

b) For sprinkler designs with or without frame arms and incorporating unsymmetrical heat responsive elements or unsymmetrical body designs, ten samples are to be orientated in the pendent position with the heat responsive element upstream of the axis of the sprinkler body.

c) For sprinkler designs incorporating frame arms with symmetrical heat responsive elements, ten samples are to be orientated in the pendent position with the frame arms in a plane perpendicular to the direction of air flow.

d) For ceiling style sprinkler designs incorporating removable cups, escutcheons, and removable closure assemblies, ten samples are to be orientated in the pendent position with the closure assemblies removed. For ceiling style sprinkler designs incorporating an integral closure assembly, ten samples are to be orientated in the pendent position with the heat responsive element exposed to the air flow.

19.2.4 The samples are to be conditioned at 75 ±2°F (24 ±1°C) for at least 2 hours. The inlet end of each sprinkler sample is to be connected to a source of air pressure at 4 ±1 psig (28 ±7 kPa) and quickly plunged into the sensitivity test oven in a pendent position. The operating time is to be measured using a timer capable of measuring 0.01 seconds and accurate to within 0.01 ±0.01 seconds. Each sprinkler is to be observed to determine if operation occurs as intended within the time specified in 19.2.1.

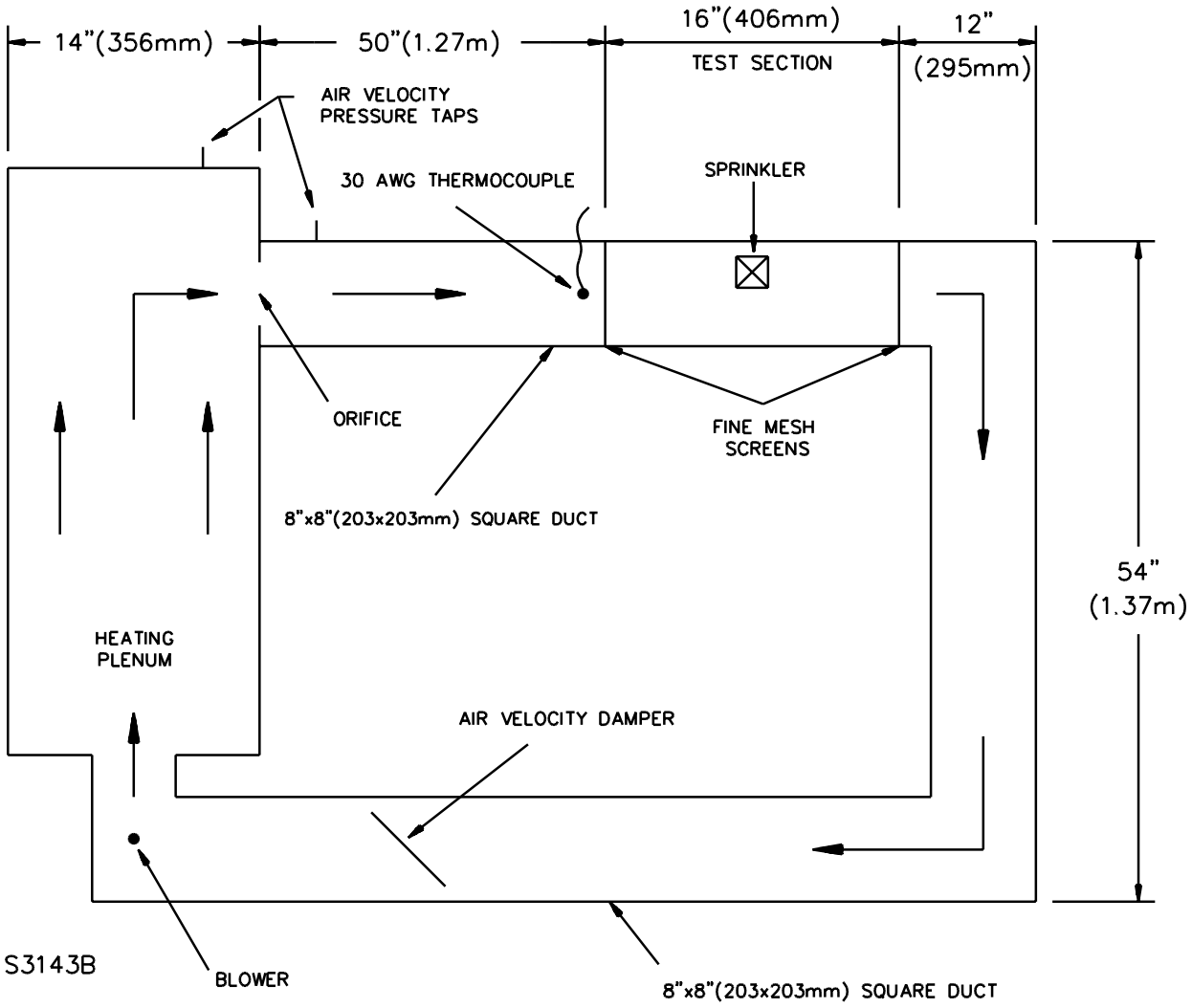
Revised 19.2.4 effective June 8, 2005

19.2.5 The sensitivity test oven is to consist of an 8 inch (203 mm) square stainless steel chamber as shown in Figure 19.1. A constant air velocity of 8.33 ±0.05 feet per second (2.54 ±0.01 m/s) and an air temperature as specified in Table 19.2 for each temperature rating and style sprinkler are to be established. Air velocity is to be measured using an orifice plate and a manometer or a bidirectional probe and a velometer. The air temperature is to be measured by use of a 30 AWG (0.05 mm^2) thermocouple centered upstream from the sprinkler as shown in Figure 19.1.

Revised 19.2.5 effective June 8, 2005

Figure 19.1
Sensitivity test oven

Figure 19.1 revised May 25, 1999



19.2.6 The required sprinkler operating time values specified in 19.2.1 and 19.2.2 shall be calculated by using the following equation:

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$$t_o = \frac{-RTI * \ln\left[1 - \left[\frac{(T_m - T_u)}{T_g - T_u}\right]\right]}{\sqrt{u}}$$

S4739

Where:

RTI: Response Time Index $[(m \cdot s)^{1/2}; (ft \cdot s)^{1/2}]$

t_o: Operating time of the sprinkler [s]

u: Nominal gas velocity in the test section of the wind tunnel [2.54 m/s; 8.33 ft/s]

T_m: Marked temperature rating of the sprinkler [°C; °F]

T_g : Nominal gas temperature in test section in Table 19.2 [°C; °F]

T_u : Nominal ambient air temperature [24°C; 75°F]

Added 19.2.6 effective June 8, 2005

19.3 Sensitivity – room heat test for ordinary and intermediate temperature rated standard response ceiling type sprinklers (including concealed, flush, and recessed)

19.3.1 Ceiling type ordinary temperature rated sprinklers shall operate within the time period specified in 19.3.3(a) when installed in an 8-foot (2.4-m) high ceiling of a closed room.

19.3.2 Ceiling type intermediate temperature rated sprinklers shall operate within the time period specified in 19.3.3(b) when installed in an 8-foot (2.4-m) high ceiling of a closed room.

19.3.3 The mean response time and unbiased standard deviation for a sample of at least ten sprinklers shall be used to compute the statistical tolerance that 99 percent of the sample response times do not exceed that limit. The computed statistical tolerance limit (see Appendix A) shall be less than or equal to:

a) 3 minutes, 51 seconds for ordinary temperature rated sprinklers; and

b) 3 minutes, 9 seconds for intermediate temperature rated sprinklers.

19.3.4 Ceiling type sprinklers are to be installed in the center of the ceiling of a closed room with dimensions of 15 by 15 feet (4.57 by 4.57 m) and a ceiling 8 feet (2.4 m) high. The sample sprinkler assemblies are to be installed in accordance with the manufacturer's installation instructions in a manner that does not inhibit air flow through the escutcheons, that is, with any vented escutcheons unblocked.

19.3.5 The fire source is to consist of a 1 by 1 by 1 foot (305 by 305 by 305 mm) sandbox burner with a flow of natural gas of 340 or 915 standard cubic feet (9.6 or 25.8 m^3) per hour for ordinary and intermediate temperature rated sprinklers, respectively. This box is to be located in one of the corners of the 15 by 15 foot (4.57 by 4.57 m) room. The response test is to be started when the sprinklers are at the ambient temperature and the ambient temperature, measured in the center of the room and 10 inches (254 mm) from the ceiling is:

a) 87 ±2°F (31 ±1°C) for ordinary temperature rated sprinklers; and

b) 120 ±3°F (48.9 ±1.7°C) for intermediate temperature rated sprinklers.

19.4 Sensitivity – room heat test for standard response extended coverage sprinklers

19.4.1 An extended coverage sprinkler shall operate within a time period specified in 19.4.2 when installed on a wall or ceiling of a closed room having an 8-foot (2.4-m) high ceiling and when tested as specified in 19.4.3 – 19.4.5.

19.4.2 The mean response time and unbiased standard deviation for a sample of at least ten extended coverage sprinklers shall be used to compute the statistical tolerance limit so that there is 95 percent confidence that 99 percent of the sample response times do not exceed that limit. The computed statistical tolerance limit (see Appendix A) shall be less than or equal to:

a) 3 minutes, 51 seconds for ordinary temperature rated sprinklers intended for light hazard occupancies;

b) 3 minutes, 9 seconds for intermediate temperature rated sprinklers intended for light hazard occupancies; and

c) 2 minutes, 30 seconds for ordinary temperature rated sprinklers intended for ordinary hazard occupancies.

19.4.3 The extended coverage sprinkler is to be installed on a wall or ceiling of a closed room having an 8-foot (2.4-m) high ceiling and an area specified by the manufacturer. The deflector of a sidewall type is to be located 4 inches (102 mm) and the maximum distance below the ceiling specified by the manufacturer. The base of a horizontal sidewall type sprinkler is to be installed adjacent to the wall. The deflector of an upright or pendent type sidewall sprinkler is to be mounted at the minimum clearance from the wall or vertical surface as specified by the manufacturer. An upright or pendent sprinkler shall be tested 10 inches (254 mm) below the ceiling and located in the center of the room. A ceiling mounted type sprinkler is to be installed as specified by the manufacturer.

19.4.4 A recessed or concealed extended coverage sprinkler having a vented escutcheon is to be installed and tested in an unblocked manner, that is, in a manner that does not inhibit air flow through the escutcheon.

19.4.5 The fire source for the room heat test specified in 19.5 is to consist of a 1 by 1 by 1 foot (305 by 305 by 305 mm) sand burner with a flow of natural gas of 340 or 915 standard cubic feet (9.6 or 25.8 m^3) per hour for ordinary and intermediate temperature rated sprinklers, respectively. The burner is to be located in one of the corners opposite the wall on which the sprinkler is located for a sidewall type and located in one corner for a ceiling type. The response test is to be started when the ambient temperature measured in the center of the room and 10 inches (254 mm) from the ceiling is:

a) 87 ±2°F (31 ±1°C) for ordinary temperature rated sprinklers; and

b) 120 ±3°F (48.9 ±1.7°C) for intermediate temperature rated sprinklers.

19.5 Sensitivity – room heat test for QR and QR extended coverage sprinklers

19.5.1 Ordinary or intermediate temperature rated QR sprinklers and QR extended coverage sprinklers for light hazard occupancies shall have an operating time of 75 seconds or less for each sprinkler when tested as specified in 19.5.3 – 19.5.5. Ordinary or intermediate temperature rated QR extended coverage sprinklers for ordinary hazard occupancies shall have an operating time of 55 seconds or less for each sprinkler when tested as specified in 19.5.3 – 19.5.5.

19.5.2 A recessed or concealed sprinkler having a vented escutcheon is to be installed and tested in an unblocked manner, that is, in a manner that does not inhibit air flow through the escutcheon.

19.5.3 Sprinklers of each type are to be installed in a test room (see 19.5.4) in the following position and orientation:

a) For pendent and ceiling type sprinkler designs without frame arms and incorporating symmetrical heat responsive elements and symmetrical sprinkler bodies, ten samples are to be installed in their intended position at the ceiling.

b) For pendent and ceiling type sprinkler designs with or without frame arms and incorporating unsymmetrical heat responsive elements, ten samples are to be orientated with the heat responsive element downstream of the axis of the sprinkler body in relation to the direction of the fire source. The samples are to be in their intended position.

c) For pendent and ceiling type sprinkler designs incorporating frame arms with symmetrical heat responsive elements, ten samples are to be orientated with the frame arms in a plane parallel to the direction of the fire source. The samples are to be installed in their intended position.

d) For upright sprinklers having configurations referenced in (a), (b), and (c), ten samples are to be installed in the pendent position.

e) For sidewall sprinkler designs, ten samples are to be installed in their intended position with the deflector located 4 inches (102 mm) below the ceiling.

19.5.4 The sprinkler is to be mounted as specified in 19.5.3 on a ceiling or a wall of a closed room having an 8 foot (2.4 m) high ceiling. For a QR sprinkler, the room is to be 15 by 15 feet (4.6 by 4.6 m). For a QR extended coverage sprinkler, the room size is to be as specified by the manufacturer and be the same dimensions used for the extended coverage tests in these requirements. The sprinkler inlet waterway is to be filled with water having a temperature of 70 ±3°F (21 ±1.6°C). The water is to be pressurized to 4-1/2 ±1/2 psig (31 ±3.4 kPa), when required for sprinkler operation.

19.5.5 The fire source is to consist of a 1 by 1 by 1 foot (305 by 305 by 305 mm) sand burner located in one corner of the room with a flow of natural gas of 500 standard cubic feet (14.2 m^3) per hour for ordinary temperature rated sprinklers and 600 standard cubic feet (17.0 m^3) per hour for intermediate temperature rated sprinklers. A pendent, upright, or ceiling type sprinkler is to be installed along a diagonal line on the ceiling at a distance of 16 feet, 9 inches (5.1 m) from the corner of the room where the sand burner is located. A pendent, upright, or ceiling type extended coverage sprinkler is to be installed in the intended position at a point where a diagonal line from the corner having the burner to the opposite corner intersects an arc having a radius equal to the distance from the corner having the burner to the midpoint of the opposite wall. A sidewall sprinkler is to be installed on the midpoint of the furthest wall furthest the corner having the sand burner. The test is to be started when the ambient temperature is 87 ±2°F (31 ±1°C) for ordinary temperature rated sprinklers and 120 ±2°F (49 ±1.1°C) for intermediate temperature rated sprinklers, as measured in the center of the room 10 inches (254 mm) below the ceiling. The gas burner is to be ignited, and the operation time of the sprinkler is to be recorded.

20 Operation – Lodgement Test

20.1 An automatic sprinkler shall operate at service pressures of 7 psig (48 kPa) to the rated pressure. Upright dry-type sprinklers shall be permitted to operate at a minimum pressure in accordance with 20.2.

Revised 20.1 effective March 26, 2004

20.1.1 All operating parts shall release with sharp, positive action. Operating parts intended to be released from the sprinkler assembly shall clear the sprinkler frame and deflector so as not to impair the water distribution pattern and internal parts of dry sprinklers shall operate so as not to restrict water flow below its intended rate.

Added 20.1.1 effective March 26, 2004

20.2 An upright dry-type sprinkler of the maximum length shall operate at a pressure of 12.5 psig (86 kPa) or less. When the minimum pressure required to clear operating parts exceeds 5 psig (34 kPa), the minimum operating pressure of such a sprinkler shall be designated as two times the minimum pressure required to clear operating parts.

Revised 20.2 effective March 26, 2004

20.3 For sprinklers rated 175 psig (1.2 MPa), 30 sample automatic sprinklers or dry-type automatic sprinklers in the shortest length are to be individually tested. Each sample is to be installed in its intended installation position on a rigid piping arrangement and supplied with flowing water at service pressures in accordance with the following: five sprinklers at 7 psig (48 kPa) [when the sprinkler is a dry upright type, 12.5 psig is to be used], five sprinklers at 25 psig (172 kPa), five sprinklers at 50 psig (345 kPa), five sprinklers at 75 psig (517 kPa), five sprinklers at 125 psig (862 kPa), and five sprinklers at 175 psig (1.21 MPa). In addition, for sprinklers having ratings exceeding 175 psig (1.2 MPa), five sprinklers shall be tested at each 25 psig (172 kPa) increment from 200 psig (1.38 MPa) to the rated pressure. Each sample is then to be operated by exposing the heat responsive element to a uniform application of heat. A sprinkler does not comply when a part interfering with correct water distribution or water flow maintains

interference for a minimum of 1 minute under water flow service pressure. The service pressure and the action of the operating parts, when releasing, are to be observed to determine compliance with these requirements.

Revised 20.3 effective March 26, 2004

20.4 To determine the minimum operating pressure for upright dry-type sprinklers, five samples of maximum length are to be individually tested. Samples are to be installed on piping connected to a water supply intended for the purpose. With the supply pressure at 0 psig (0 kPa), the heat responsive element of each sample is to be operated. The service pressure is then to be increased at a rate not greater than 1 psig (7 kPa) in 15 seconds. The pressure at which internal parts clear the waterway is to be noted.

Revised 20.4 effective March 26, 2004

20.5 To determine internal parts of dry sprinklers do not restrict flow below the intended flow rate, a flow meter is to be connected to the water supply piping. Prior to operation of the 30 samples in 20.3, an operated sample that has demonstrated acceptable K-factor results in the Calibration Test fixture shall be installed in the operational test fixture. Water is to be flowed at each of the pressures noted in 20.3 and the K-factor at each pressure is to be recorded. The 30 samples are to be tested as described in 20.3. After sprinkler operation, the flow at each pressure specified in 20.3 is to be recorded. The discharge coefficient K-factor is then to be calculated as specified in 29.4. The K-factor value shall be within 5 percent of previously tested K-factor samples.

Added 20.5 effective March 26, 2004

21 Flow Endurance Test

21.1 An automatic sprinkler shall withstand for 30 minutes, without evidence of cracking, deformation, or separation of any part, a waterflow at a pressure equal to the rated pressure plus 25 psig (172 kPa).

21.1 revised October 8, 1997

21.2 One sample of an automatic sprinkler is to be installed on an elbow in a pressurized water system. The heat responsive element of the sprinkler is to be activated, and the sample subjected to water flow at the specified pressure for 30 minutes.

22 Operation – Cold Soldering Test

22.1 General

22.1.1 When tested in accordance with 22.1.2 – 22.1.5 and while discharging water at a service pressure of 75 psig (517 kPa) less than the rated pressure, an open pendent, upright, sidewall or extended coverage sprinkler shall not prevent the operation of a second ordinary-temperature rated automatic sprinkler of the same type. When tested in accordance with 22.1.2, while discharging water at a service pressure of 100 psig (698 kPa), an open pendent or upright intermediate level sprinkler shall not prevent the operation of a second ordinary-temperature rated automatic sprinkler of the same type.

22.1.1 effective October 8, 1999

22.1.2 For pendent and upright sprinklers, an automatic and open sprinkler are to be installed on parallel pipe lines with the sprinklers located 6 feet (1.8 m) apart, and the frame arms parallel to the pipe line. The sprinkler deflectors are to be located 6, 14 and 22 inches (152, 356 and 559 mm) below a flat ceiling.

22.1.2 effective October 8, 1999

22.1.3 For horizontal sidewall sprinklers, an automatic and open sprinkler are to be installed on the same pipe line with the sprinklers located 6 feet (1.8 m) apart or the minimum distance between sprinklers as specified in the installation instructions, to discharge water perpendicular to the pipe line. The sprinklers are to be located 6 and 12 inches (152 and 305 mm) below a flat ceiling and 6 inches (152 mm) away from a back wall.

22.1.3 effective October 8, 1999

22.1.4 For extended coverage and vertical sidewall sprinklers, the sprinkler is to be installed in the manner as described in 22.1.2 or 22.1.3, whichever is applicable based on the style of sprinkler tested, except that the sprinkler spacing is to be the minimum distance between sprinklers as specified in the installation instructions.

22.1.4 effective October 8, 1999

22.1.5 Water is to be discharged from the open sprinkler at a service pressure of 100 psig (689 kPa). Under this condition, the automatic sprinkler is to be exposed to the heat and flame from a 1-foot-square (305-mm-square) pan, 4 inches (102 mm) deep containing 1 pint (0.47 liter) of heptane (see 34.4.9), with the top of the pan located 6 inches (152 mm) below the heat responsive element of the automatic sprinkler. Observations are to be made for operation of the automatic sprinkler. Non-operation of the automatic sprinkler is an indication that the open sprinkler discharge prevented the automatic sprinkler from operating.

22.1.5 effective October 8, 1999

22.2 Intermediate level sprinklers

22.2.1 An ordinary-temperature rated sprinkler is to be installed in the center of and located 7 feet, 6 inches (2.29 m) below four open sprinklers which are located on the corners of a 10- by 10-foot (3- by 3-m) square. Water is to be discharged from the open sprinklers at a service pressure of 7 psig (48 kPa) per sprinkler. Under this condition, the closed sprinkler is to be exposed to the heat and flame from a 1-foot (305-mm) square pan, 4 inches (102 mm) deep, containing 1 pint (0.47 L) of heptane. The top of the pan is to be located 6 inches (152 mm) below the heat-responsive element of the closed sprinkler. The test sprinkler shall operate before the fuel is consumed. The test is then to be repeated with the closed sprinkler 5 feet (1.52 m) below the four open sprinklers.

23 High Temperature – Test For Uncoated Sprinklers

23.1 An uncoated automatic sprinkler shall withstand for 90 days, without evidence of weakness or malfunction, an exposure to a high-ambient temperature in accordance with Table 23.1, or 20°F (11°C) below the rated operating temperature of the samples (whichever is the lower temperature), and not less than 120°F (49°C). To evaluate weakness and malfunction following the exposure, each sprinkler shall comply with the Leakage Test, Section 14. Also, sprinklers of other than the dry type and QR recessed, QR concealed, QR-EC recessed, and QR-EC concealed are to then be subjected to the Sensitivity – Oven Heat Test, see 19.2.1 – 19.2.5. The Sensitivity – Room Heat Test is to be conducted on QR recessed, QR concealed, QR-EC recessed and QR-EC concealed type sprinklers, see 19.3.1 – 19.3.5; and the Response Test for Ordinary and Intermediate Temperature Rated Ceiling Type Sprinklers is to be conducted on standard response type recessed and concealed sprinklers, see 19.3.1– 19.3.5. Each sample shall be operable, and the average time of operation shall not increase more than a 1.3 multiple when compared to the average time of samples not subjected to the High Temperature – Test for Uncoated Sprinklers. Dry-type sprinklers are to then be subjected to the plunge test described in 35.3.

23.1 revised July 9, 2001

Table 23.1
High-temperature exposure test conditions

Sprinkler temperature rating		High ambient test temperature	
Degrees F	(Degrees C)	Degrees F	(Degrees C)
135 – 140	57 – 60	120	49
145 – 170	63 – 77	125	52
175 – 225	79 – 107	175	79
250 – 300	121 – 149	250	121
325 – 375	163 – 191	300	149
400 – 475	204 – 246	375	191
500 – 575	260 – 302	475	246

23.2 An automatically-controlled, circulating-type, constant-temperature oven is to be used for this test. Five automatic sprinklers of each operating temperature are to be placed in an oven at the specified test temperature.

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24 High Temperature – Test For Coated Sprinklers

24.1 A coated automatic sprinkler shall withstand for 90 days without evidence of deterioration or malfunction an exposure to a high-ambient temperature as specified in Table 7.1, or 20°F (11°C) below the rated operating temperature of the samples (whichever is the lower temperature), and not less than 120°F (49°C). Following the exposure, the coating shall not show evidence of deterioration such as cracking, flaking, or flowing. To evaluate malfunction following the exposure, sprinklers of other than the dry-type then are to be subjected to the Sensitivity – Oven Heat Test, see 19.2.1 – 19.2.5, and dry-type sprinklers are then to be subjected to the plunge test described in 35.3.

24.1 revised July 9, 2001

24.2 An automatically-controlled, circulating-type, constant-temperature oven is to be used for this test. Five automatic sprinklers with each type of coating are to be placed in the oven at the specified test temperatures.

25 Strength Of Frame Test

25.1 An automatic sprinkler frame shall not show permanent distortion in excess of 0.2 percent of the distance between its bearing points when subjected to a test loading of twice its assembly load at rated hydrostatic pressure.

25.2 The distance between load-bearing points is to be measured to the nearest 0.001 inch (0.03 mm) from the plane of the sprinkler-orifice outlet at the center of the orifice to the center of the compression bearing surface.

25.3 At least ten sprinkler samples are to be individually installed in a test apparatus that applies a load to the upper compression bearing surface. A measuring instrument is to be attached to indicate the amount of deflection at the deflector end of the sprinkler frame.

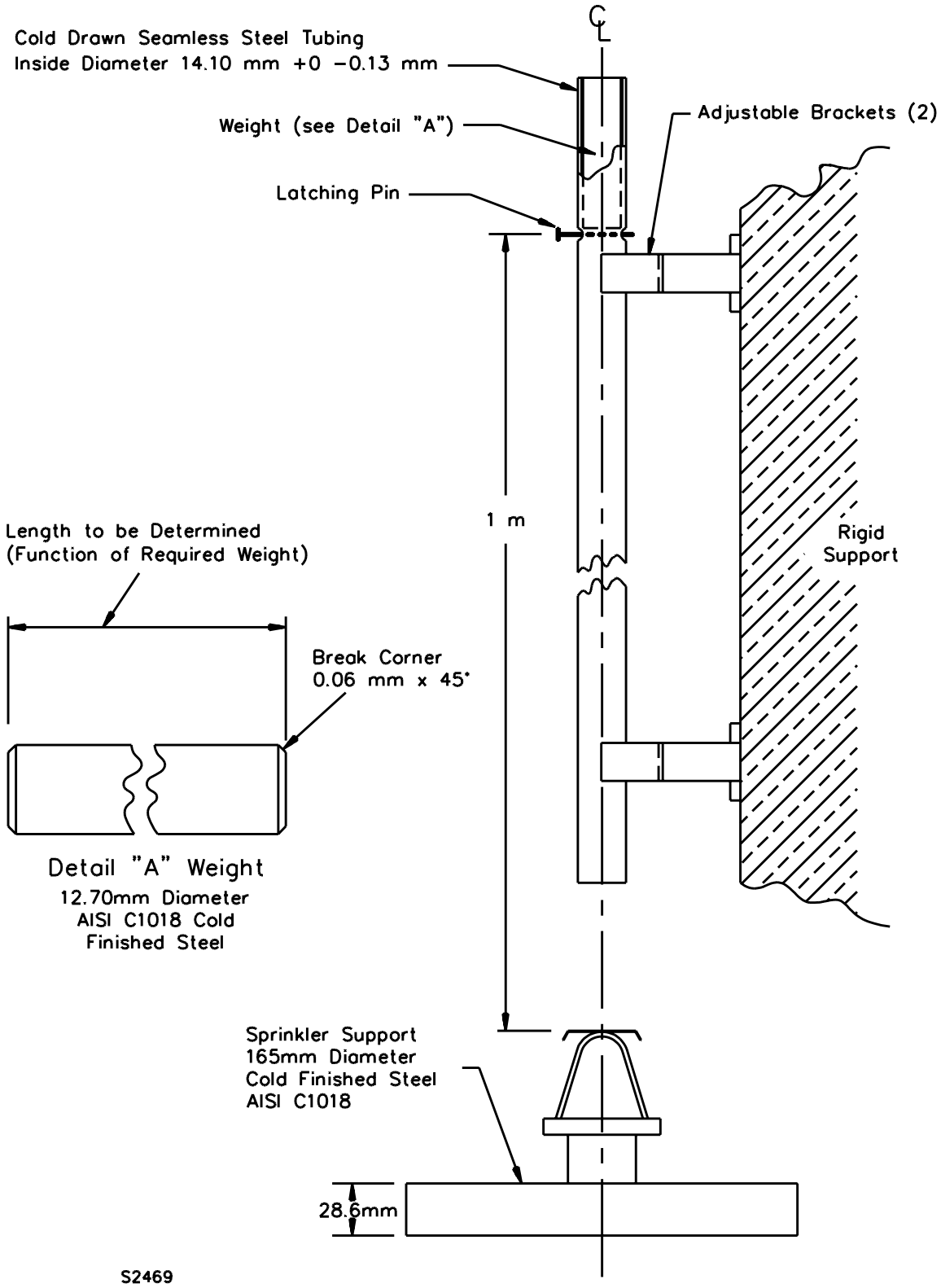
25.4 The heat responsive element of the sample is to be carefully removed so as not to damage the frame. The negative deflection, due to release of the assembly load, is to be recorded. A load is then to be applied to redeflect the sprinkler at a rate of 0.02 inch (0.51 mm) per minute until the deflection returns to zero. The load at zero deflection is to be recorded as the assembly load.

25.5 A load of twice the assembly load at rated pressure is then to be applied to the individual sample. The deflection during the load application and the amount of permanent set after the load application are to be determined to verify compliance with the requirements in 25.1.

26 Impact Resistance Test

26.1 An automatic sprinkler shall not be damaged or leak when tested as described in 26.2. See Figure 26.1.

Figure 26.1
Impact test apparatus



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26.2 Five sample 5.6 nominal "K" factor sprinklers are to be tested by dropping a cylindrical mass equivalent to the mass of the sprinkler to the nearest 15-g increment from a height of one meter onto the geometric center of the deflector or, when this is not practicable, onto the butt end of the sprinkler. The mass is to be prevented from impacting more than once upon each sample. Following the impact, each sprinkler is to be visually examined and there shall be no evidence of cracks, breaks, or any other damage. Each sample sprinkler shall then withstand a 435 psig (3 MPa) hydrostatic pressure for 1 minute without leakage. In addition, each sample shall then be subjected to the Sensitivity – Oven Heat Test, see 19.2.1 – 19.2.5, and shall operate at within a 1.3 multiple of the mean time obtained on samples not subjected to the Impact Resistance Test.

26.2 revised January 24, 2000

27 Rough Usage Test

27.1 An automatic sprinkler shall withstand the effects of rough usage without deterioration of its performance characteristics. Following 3 minutes of tumbling as described in 27.3, the sprinkler shall comply with the Leakage Test, Section 14, and the Sensitivity Tests, Section 19.

27.1 effective October 8, 1998

27.2 Five sample sprinklers are to be tested. The sprinklers are to be tested with a shipping protector in place when the protector is intended to be removed from the sprinkler after the sprinkler is installed and reference to this removal requirement is made in the installation instructions.

27.2 effective October 8, 1998

27.3 Five samples are to be individually placed in a vinyl-lined right hexagonal prism-shaped drum[a] designed to provide a tumbling action. The drum is to have an axis of rotation of 10 inches (254 mm). The distance between opposite sides is to be 12 inches (305 mm). For each test, one sample and five 1-1/2-inch (38.1-mm) hardwood cubes are to be placed in the drum. The drum is to be rotated at 1 revolution per second for 3 minutes. The sample is to be removed from the drum, examined for signs of damage, and then subjected to the Leakage Test, Section 14, and to the Sensitivity Tests, Section 19.

[a]A drum acceptable for this test is available from Kramer Industries, Inc., Copiague, NY 11726, Model K1401.

27.3 effective October 8, 1998

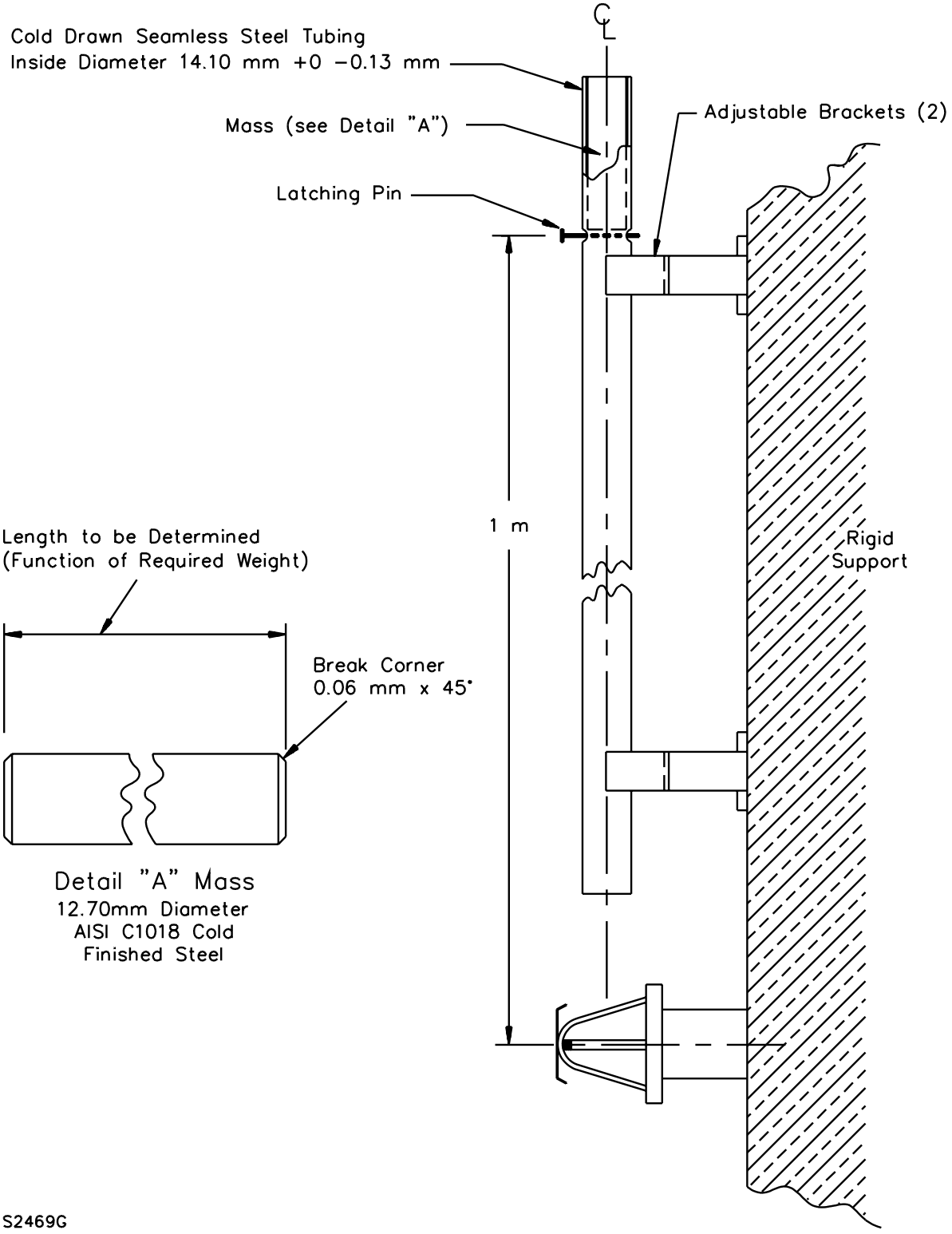
27A Impact Test for Protective Covers

27A.1 A frangible bulb type sprinkler, with the protective cover installed, shall not be damaged or leak when tested as described in 27A.2. See Figure 27A.1.

27A.1 effective September 26, 2004 for sprinklers with a glass bulb having a diameter of greater than 4 mm

Figure 27A.1
Impact test apparatus for protective covers

Figure 27A.1 effective September 26, 2004 for sprinklers with a glass bulb having a diameter of greater than 4 mm



27A.2 Five sample frangible bulb sprinklers with their protective covers are to be mounted in the horizontal position and impacted with a cylindrical mass equivalent to the mass of the sprinkler to the nearest 15-gram increment from a height of one meter onto the geometric center of the frangible bulb heat responsive element. If the frangible bulb extends beyond the perimeter of the sprinkler deflector, an additional five sample sprinklers are to be mounted in the vertical position and impacted with the same cylindrical mass from a height of one meter onto the geometric center of the frangible bulb heat responsive element. The mass is to be prevented from impacting more than once upon each sample. Following the impact, each sprinkler is to be visually examined and there shall be no evidence of cracks, breaks, or any other damage to the frangible bulb. Each sample sprinkler shall then withstand a 435 psig (3 MPa) hydrostatic pressure for 1 minute without leakage. In addition, each sample shall then be subjected to the Sensitivity – Oven Heat Test, see 19.2, and shall operate at within a 1.3 multiple of the mean time obtained on samples not subjected to the Impact Resistance Test.

27A.2 effective September 26, 2004 for sprinklers with a glass bulb having a diameter of greater than 4 mm

28 Vibration Test

28.1 An automatic sprinkler shall withstand the effects of vibration without deterioration of its performance characteristics. The sprinkler is to be subjected to vibration of 0.04 inch (1.0 mm) amplitude for 120 hours at a frequency that is continuously varied between 18 and 37 hertz. However, when the sprinklers exhibit resonance at a frequency within the range of 18 to 37 hertz, the resonant frequency is to be used for the entire test period. Following the vibration test, the sprinkler shall comply with the Leakage Test, Section 14. In addition, the sprinkler shall operate as intended when subjected to the Sensitivity – Oven Heat Test, see 19.2.1– 19.2.5.

28.2 Five sprinkler samples are to be threaded into the pipe couplings on a steel mounting plate, and the plate is to be bolted to the table of a vibration machine so that the sprinklers are mounted vertically. When dry sprinklers are tested, they are to be samples of the maximum length. The test sprinklers then are to be vibrated in the vertical direction.

28.3 This test is to be conducted with the test sprinklers unpressurized.

28.4 For these tests, amplitude is defined as the maximum displacement of sinusoidal motion from position of rest to one-half of the total table displacement; resonance is defined as the maximum magnification of the applied vibration.

29 Calibration Test

29.1 The discharge coefficient ″K″ of a sprinkler shall be determined and shall comply with the requirements specified in Nominal “K” Factors, Section 8.

29.1 revised January 24, 2000

29.2 The sprinkler is to be installed on an outlet from a reservoir sized so that the velocity head effect ($V^2/2$ g) is reduced to approach a velocity of zero. The outlet is to consist of a pipe coupling of a size corresponding with the size of the sprinkler thread (1/2, 3/4 or, 1 inch NPT), as described in the Standard for Pipe Threads, General Purpose (Inch) (Revision and Redesignation of ASME/ANSI B2.1-1968)(R1992), ASME B1.20.1-1983. For sprinklers having a nominal “K” factor of 8 or less, the coupling is to be installed in the reservoir by positioning the coupling in a hole so that the inlet to the coupling protrudes into the interior of the reservoir 1/8 inch (3.2 mm) or more. See Figure 29.1 as an example of the apparatus. For sprinklers having a nominal “K” factor greater than 8, the outlet shall consist of a nominal six-inch blank flange drilled and threaded to the appropriate thread size, and attached to a six-inch pipe. See Figure 29.2 for an example of this apparatus.

29.2 revised January 24, 2000

Figure 29.1
Calibration test equipment

Figure 29.1 revised May 25, 1999

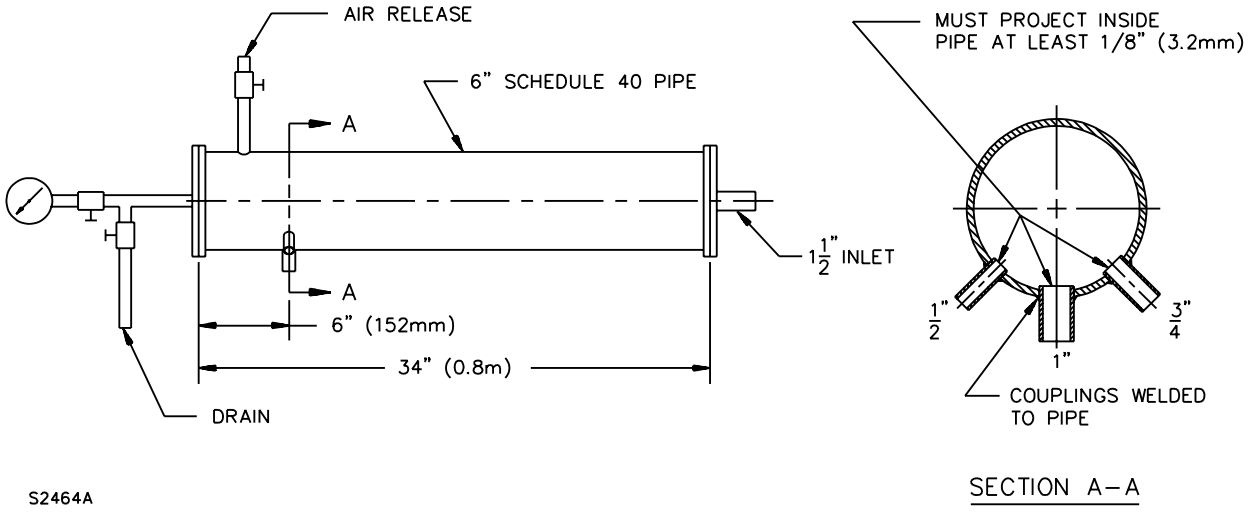
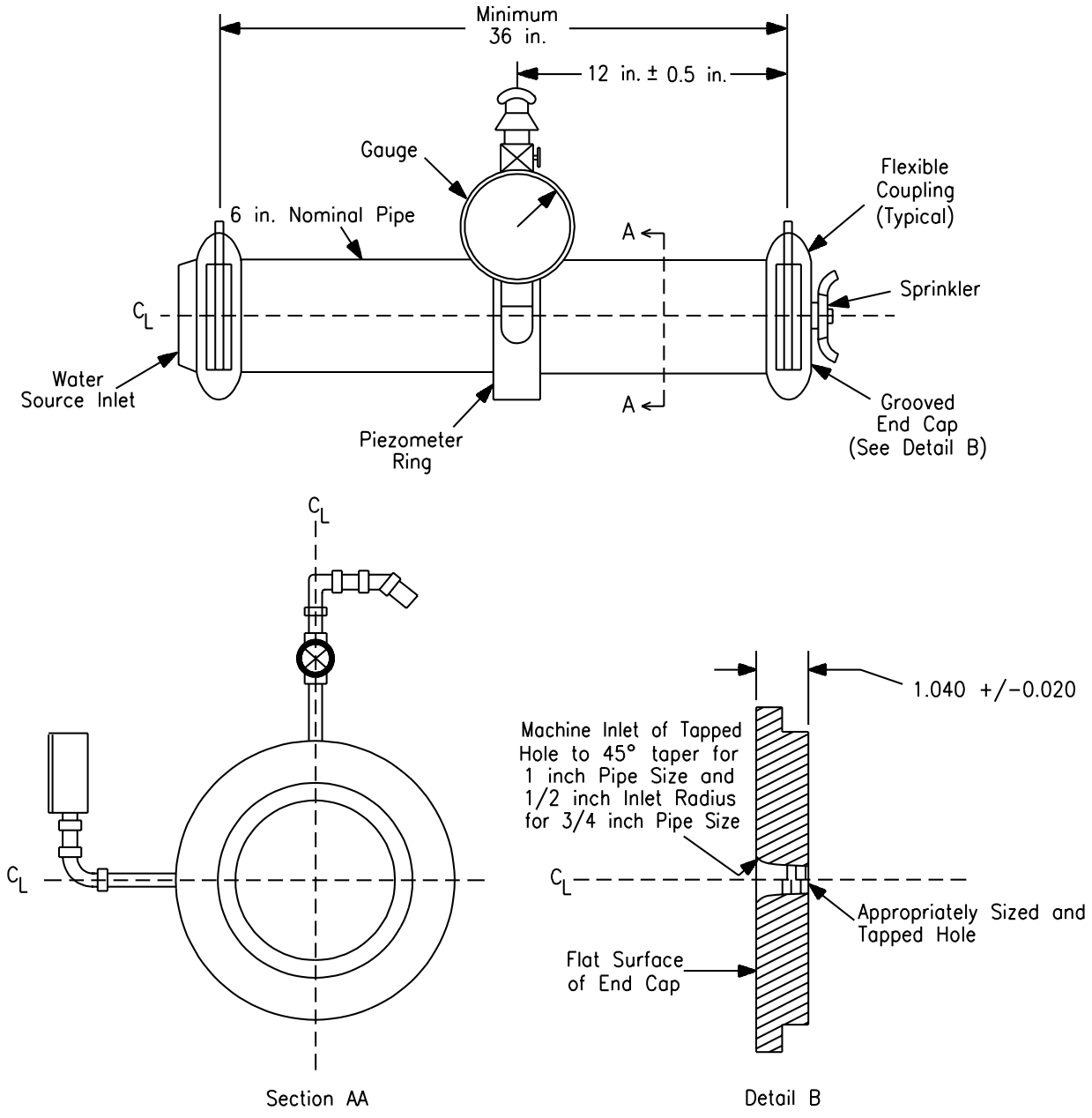


Figure 29.2
Calibration test equipment for sprinklers with "K" factors greater than eight

Figure 29.2 revised March 26, 2003



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Note: All dimensions are nominal size except as noted

29.3 When dry-type sprinklers are tested, the range of lengths tested is to include the maximum and minimum lengths to be produced. The minimum length is to be used to determine compliance with the requirements specified in 8.2.

29.4 The sprinkler sample is to be flow tested first at a pressure of 7 psig (48 kPa) and then at 10 psig (69 kPa). Following this, the pressure is to be increased in 5 psig (34 kPa) increments up to 50 psig (345 kPa), in 10 psig (69 kPa) increments up to and including 75 psig (517 kPa) less than the rated pressure, decreased in 10 psig (69 kPa) increments down to 50 psig (345 kPa), in 5 psig (34 kPa) increments down to 10 psig (60 kPa), and then decreased to 7 psig (48 kPa). The flow at each increment of pressure is to be measured by a flow-measuring device having an accuracy of within 2 percent of the actual flow. The discharge coefficient ″K″ is to be calculated by dividing the flow in gallons per minute (L/S x 15.85) by the square root of the pressure in psig (MPa x 145). The average discharge coefficient ″K″ is then to be calculated.

29.4 revised October 8, 1997

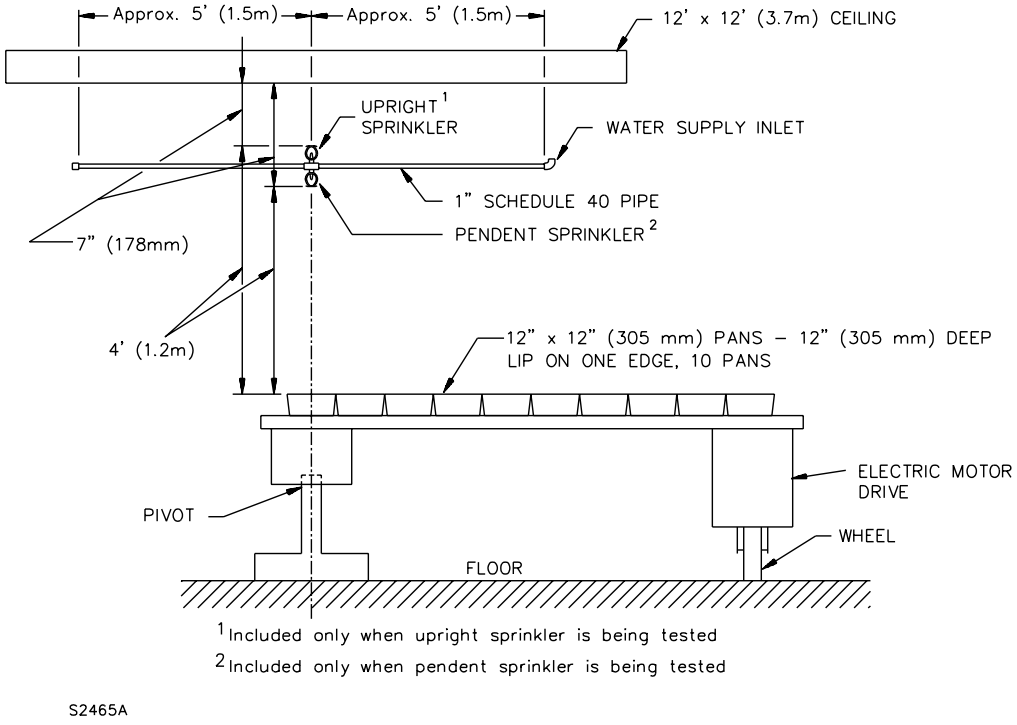
30 10 Pan Distribution Test

30.1 When tested as described in 30.3 and 30.4, the water-distribution pattern from a sprinkler, except as noted in 30.2, shall not exceed a 16 foot (4.88 m) diameter circular area located in a horizontal plane 4 feet (1.22 m) below the sprinkler deflector.

30.2 Water shall not accumulate in areas outside the 16 foot (4.88 m) diameter circle unless the accumulations do not exceed 0.03 gallons per minute per square foot (0.007 L/s per m^2).

30.3 An open sprinkler is to be installed in its intended position (upright or pendent) in a tee fitting 1 inch by 1 inch with an inlet the size of the sprinkler, supplied with water by 1 inch piping flowing from one direction. The sprinkler deflector is to be located 7 inches (178 mm) below a minimum 12 by 12 foot (3.65 by 3.65 m) smooth, flat, horizontal ceiling. The frame arms are to be parallel to the piping on which installed. A ceiling or recessed type sprinkler is to be mounted in the ceiling in the intended installation position. The deflector is to be 4 feet (1.22 m) above a row of ten 1-foot-square (305-mm-square) collection pans mounted on a rotating table which has its pivot placed directly below the center of the sprinkler sample. The center of the first pan is to be directly below the center of the sprinkler. See Figure 30.1.

Figure 30.1
10 pan sprinkler distribution test arrangement



30.4 With the table and pans rotating at 1 revolution per minute (rpm), water is to be discharged from the sprinkler for a minimum of 10 minutes or until a pan is filled with water, whichever occurs first and at a rate of 15 gallons per minute (0.95 L/s) for 1.4, 1.9, 2.8, 4.2, and 5.6 nominal "K" factor sprinklers and at a rate of 21 gallons per minute (1.32 L/s) for 8.0 nominal "K" factor sprinklers. The water collected is to be measured and the density in gallons per minute per square foot (L/s per m^2) calculated.

30.4 revised January 24, 2000

31 16 Pan Distribution Test

31.1 Four sprinklers, flowing at the rates indicated in Table 31.1 and tested as specified in 31.2 – 31.6, shall discharge water at an average density of:

a) Not less than the average shown in Table 31.1 for the 16 pans (see 31.5); and

b) Not less than 75 percent of the specified average for any individual pan.

Table 31.1
16 pan sprinkler distribution tests

Table 31.1 revised January 24, 2000

	Waterflow per sprinkler		Minimum average collection	
Nominal ″K″ Factor	gpm	(L/s)	gpm/ft^2	(L/s per m^2)
1.4	3.75	0.24	0.0375	0.02
1.9	5.25	0.33	0.0525	0.04
2.8	7.50	0.47	0.0750	0.05
4.2	11.25	0.71	0.1125	0.08
5.6	15.00	0.95	0.1500	0.11
8.0	21.00	1.32	0.2100	0.14

31.1.1 Sprinklers rated at a pressure greater than 175 psig (1.2 MPa), shall be tested at a flow rate corresponding to a pressure of 75 psig (517 kPa) less than the rated pressure and comply with the requirements of 31.1 (a) and (b) for the ″K″ factor specified.

31.1.1 revised January 24, 2000

31.2 Two distribution tests are to be conducted. After completion of the first test, two of the four sprinklers in opposite corners are to be transposed, prior to conducting the second test. The results of each test shall be in accordance with 31.1.

31.3 Four open sprinklers are to be installed in their intended position (upright or pendent) in 90 degree elbows having a 1 inch inlet and an outlet the same size as the sprinkler inlet, each supplied with water through 1 inch piping, with sprinkler deflectors located 7 inches (178 mm) below a minimum 12- by 12-foot (3.66- by 3.66-m) smooth, flat, horizontal ceiling. The frame arms are to be parallel to the piping on which installed.

31.4 Each ceiling or recessed type sprinkler is to be mounted in the center of a minimum 2- by 2-foot (0.61- by 0.61-m) square ″ceiling″ in the intended installation position. When dry-type sprinklers are tested, the shortest available length is to be used.

31.5 The four sprinklers are to be installed at the corners of a 10- by 10- foot (3.05- by 3.05-m) square. Sixteen 1-foot-square (305-mm^2) pans, located 7 feet, 6 inches (2.29 m) below the sprinkler deflectors and centered between the sprinklers, are to be used to collect the sprinkler discharge. See Figure 31.1.

31.6 Water is to be discharged for a minimum of 10 minutes. The amount collected in each pan is to be measured, and the density in gallons per minute per square foot (L/s per m^2) calculated.

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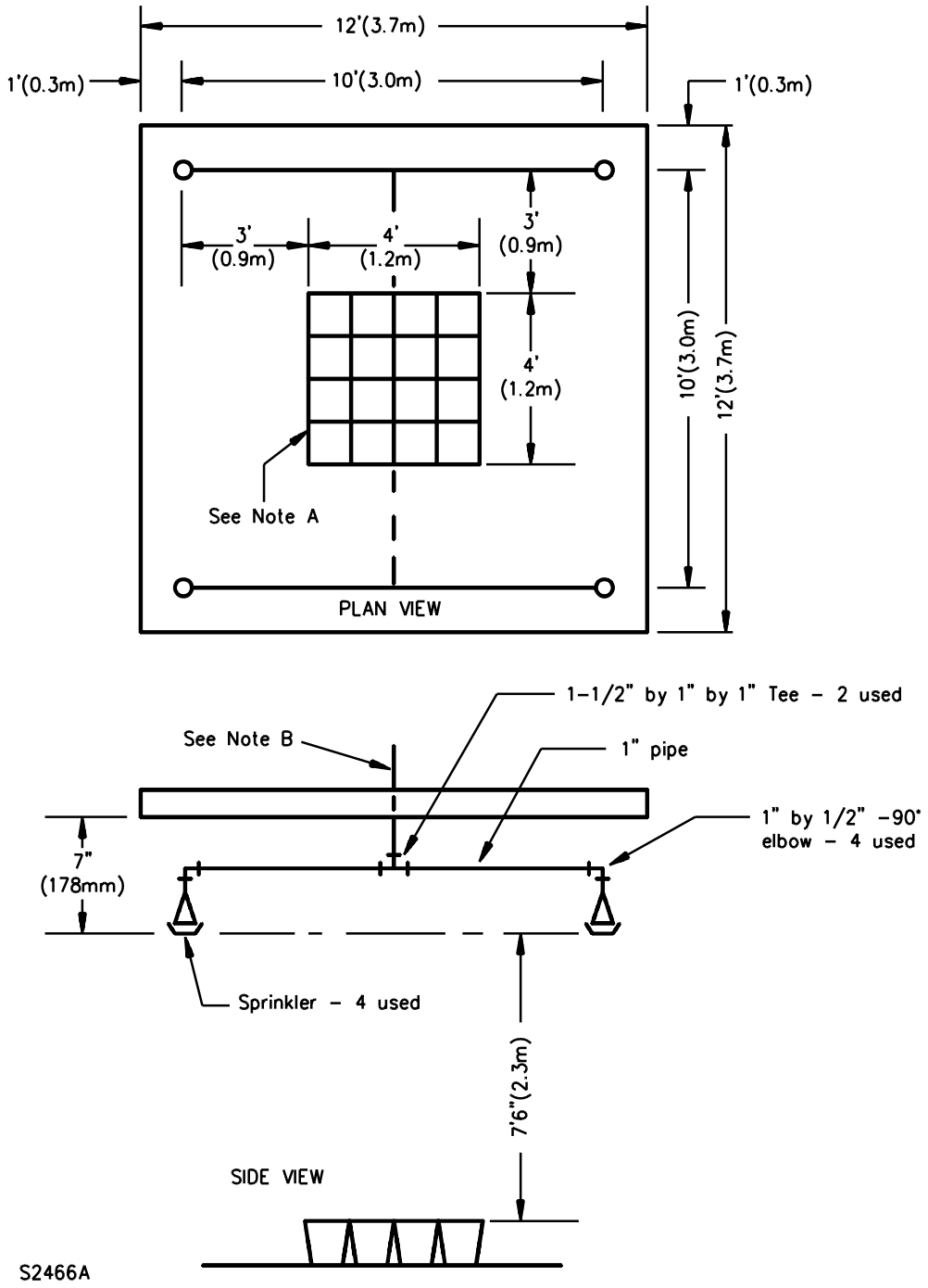
Figure 31.1
16 pan sprinkler distribution test arrangement



Note: A – 16 pans, 12 by 12 by 12 inches (0.3 by 0.3 by 0.3 m) deep.

B – Piping above ceiling and connecting piping to sprinkler branch piping all 1-1/2 inch.

32 Water Distribution Test – Conventional (Old Style) Sprinklers

32.1 When a conventional (old style) sprinkler is flowing water at the rate specified in Table 32.1 for various sprinkler "K" factors, the number of containers in which the quantity of water is less than 50 percent of the water coverage specified in column 2 of Table 32.1 shall not exceed the value specified in column 6 of Table 32.1.

32.1 revised January 24, 2000

Table 32.1
Water coverage values for conventional sprinklers

Table 32.1 revised March 26, 2003

Nominal ″K″ Factor	Water coverage		Flow rate per sprinkler		Protected area		Sprinkler spacing		Number of containers with a lower content of water
	mm/min	(gpm/ft^2)	l/min	(gpm)	m^2	(ft^2)	m	(ft)	
4.2	2.5	(0.06)	50.6	(13.4)	20.25	(217.8)	4.5	(14.76)	8
5.6	5.0	(0.12)	61.3	(16.2)	12.25	(131.8)	3.5	(11.48)	5
	15.0	(0.36)	135.0	(35.7)	9	(96.8)	3	(9.84)	4
8.0	10.0	(0.24)	90.0	(23.8)	9	(96.8)	3	(9.84)	4
	30.0	(0.72)	187.5	(49.5)	6.25	(67.2)	2.5	(8.2)	3

32.2 Four sprinklers of the same type shall be installed in a test chamber having minimum dimensions 7 by 7 m (23 by 23 feet) and maximum dimensions 8 by 8 m (26 by 26 feet). The sprinklers shall be arranged in a square, on piping prepared for this purpose. The arrangement of the piping and collection pans is shown in Figures 32.1 – 32.4. The frame arms of the sprinklers shall be positioned parallel to the supply pipes.

32.2 effective October 8, 1998

Figure 32.1
Layout of water distribution collection room
[Measured area 20.25 m^2 (217.9 ft^2)]

Figure 32.1 effective October 8, 1998

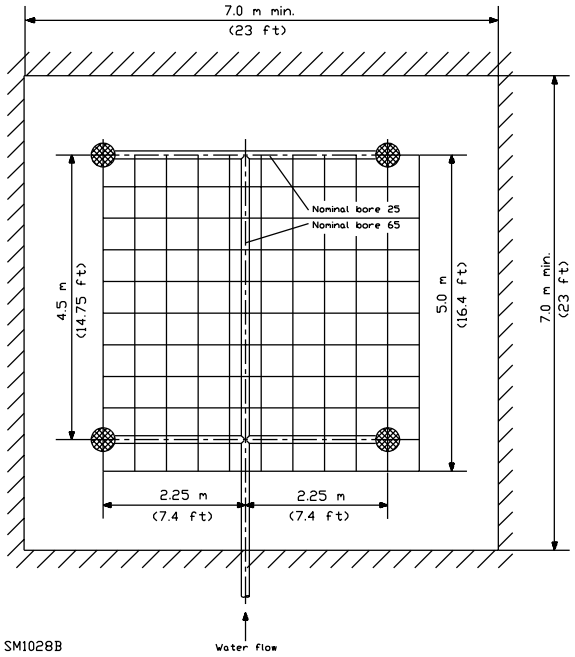


Figure 32.2
Layout of water distribution collection room
[Measured area 12.25 m^2 (131.8 ft^2)]

Figure 32.2 effective October 8, 1998

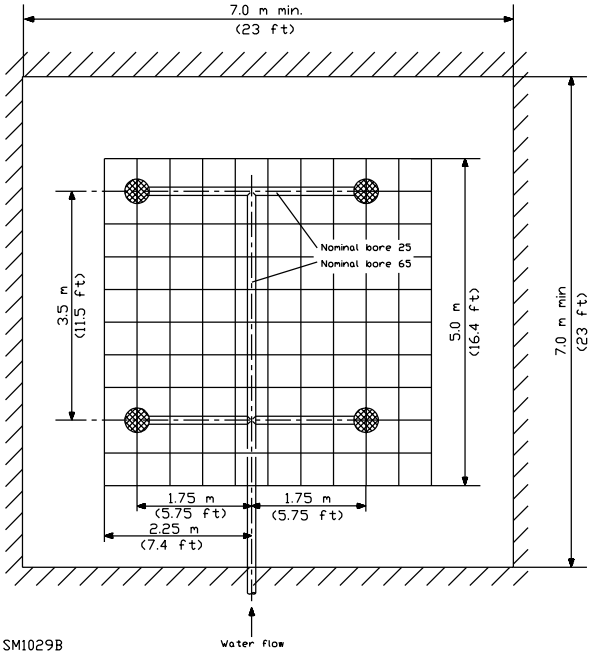


Figure 32.3
Layout of water distribution collection room
[Measured area 9 m^2 (96.8 ft^2)]

Figure 32.3 effective October 8, 1998

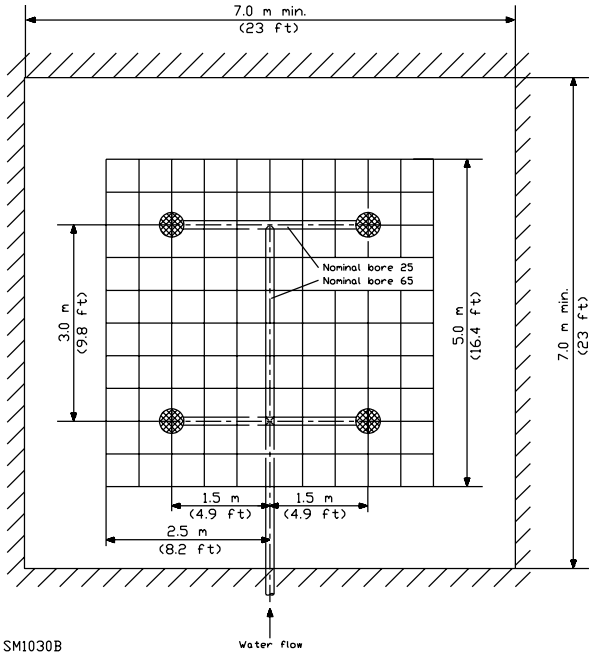
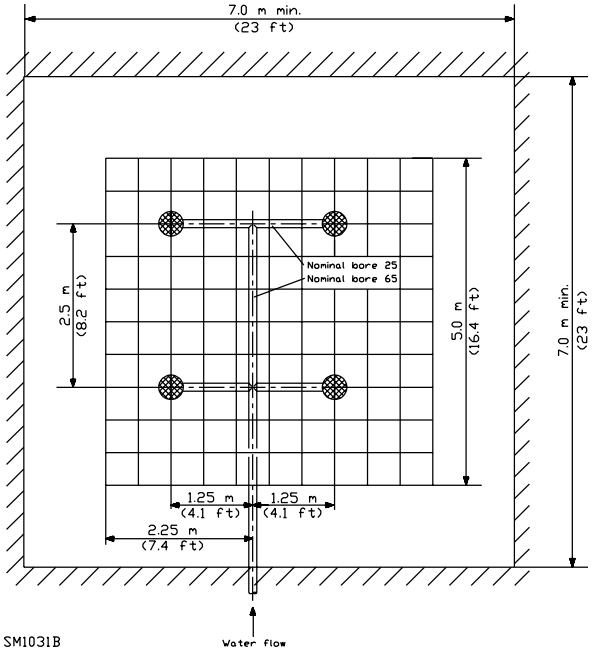


Figure 32.4
Layout of water distribution collection room
[Measured area 6.25 m^2 (67.24 ft^2)]

Figure 32.4 effective October 8, 1998



32.3 Water is to be discharged for a minimum of 10 minutes, and the amount collected in each pan is to be measured and recorded to determine the amount and uniformity of discharge.

32.3 effective October 8, 1998

32.4 Flush or recessed type sprinklers shall be mounted in a false ceiling of dimensions not less than 6 by 6 m (20 by 20 feet), arranged symmetrically in the test chamber. The sprinklers shall be fitted directly into the horizontal pipework by means of tee or elbow fittings.

32.4 effective October 8, 1998

32.5 The area covered and the water density of coverage for the three nominal "K" factors are given in Table 31.1.

32.5 revised January 24, 2000

32.6 The water distribution in the area between the four sprinklers shall be measured by means of square collection pans of size 500 mm (19.7 inches). The distance between the ceiling and the upper edge of the collection pans shall be 2.7 m (8.9 feet). The pans shall be positioned centrally in the room, beneath the four sprinklers. The water shall be collected for at least 3 min.

32.6 effective October 8, 1998

32.7 The water discharge of sprinklers downward from the deflectors is to be 40 to 60 percent for conventional sprinklers and 80 to 100 percent for spray sprinklers. The sprinklers are to be installed horizontally in a testing rig as shown in Figure 32.5. The deflector is to be positioned within the apparatus so that a theoretical dividing line between the two collecting volumes intersects a point on the axis of the sprinkler where the water spray is travelling substantially parallel to the plane of the partition. The sprinklers are to be tested at the flow conditions specified in Table 32.2.

Added 32.7 effective October 8, 1998

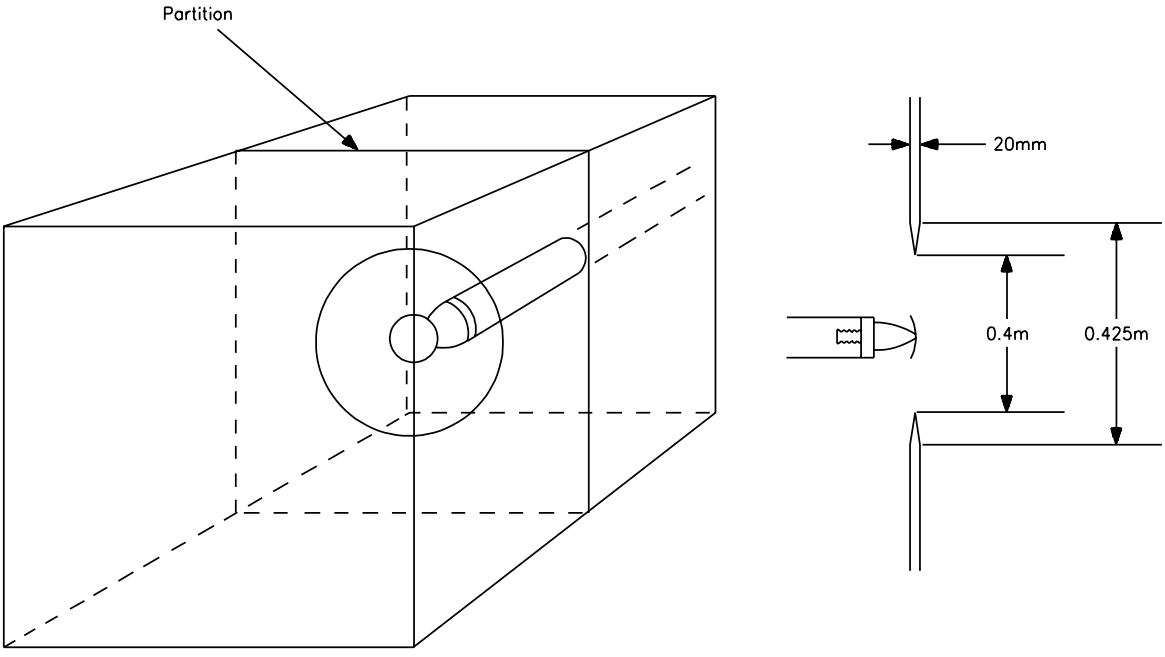
Table 32.2
Flow conditions

Table 32.2 revised March 26, 2003

Nominal ″K″ Factor	Water flow rate	
	l/minute	(gal/min)
4.2	50.6	(13.4)
5.6	61.3	(16.2)
8.0	90	(23.8)

Figure 32.5
Water distribution above and below the deflectors

Added Figure 32.5 effective October 8, 1998



S3915

33 100 Pan Distribution Test– Sidewall Sprinklers

33.1 When tested as described in 33.3 – 33.5, the water distribution from two sidewall sprinklers over a 100 foot square (9.3 m^2) floor area covered by 100 collection pans (see Figure 33.1) shall be as follows:

a) For 1.4, 1.9, 2.8, 4.2, and 5.6 nominal "K" factor sprinklers, a minimum average water collection in the pans of 0.050 gpm/ft^2(0.034 L/s per m^2), and a minimum water collection of 0.030 gpm (0.00018 L/s) for any individual pan.

b) For 8.0 nominal "K" factor sprinklers, a minimum average water collection in the pans of 0.070 gpm/ft^2(0.048 L/s per m^2), and a minimum water collection of 0.030 gpm (0.00026 L/s) for any individual pan.

33.1 revised January 24, 2000

33.2 When tested as described in 33.3– 33.5, each sidewall sprinkler shall wet an area of a smooth wall located behind the sprinkler to within 4 feet (1.2 m) below the level of the sprinkler deflector. Such wetting shall account for a minimum of 3.5 percent of the total discharge at the minimum pressure specified in 33.4. The entire area shall be completely wetted within the curvilinear shape defined by the intended floor area and the apex located 4 feet below the deflector.

33.2 revised October 8, 1997

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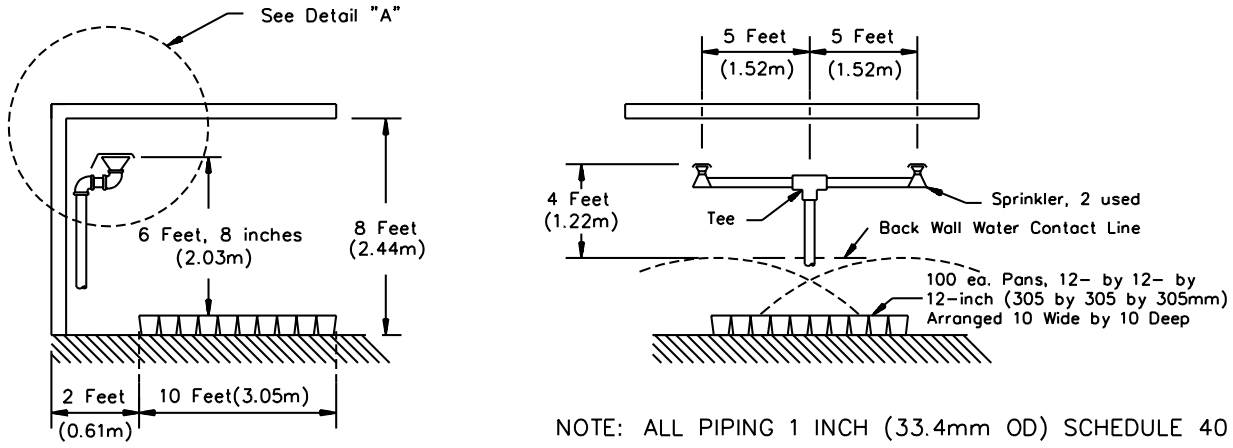
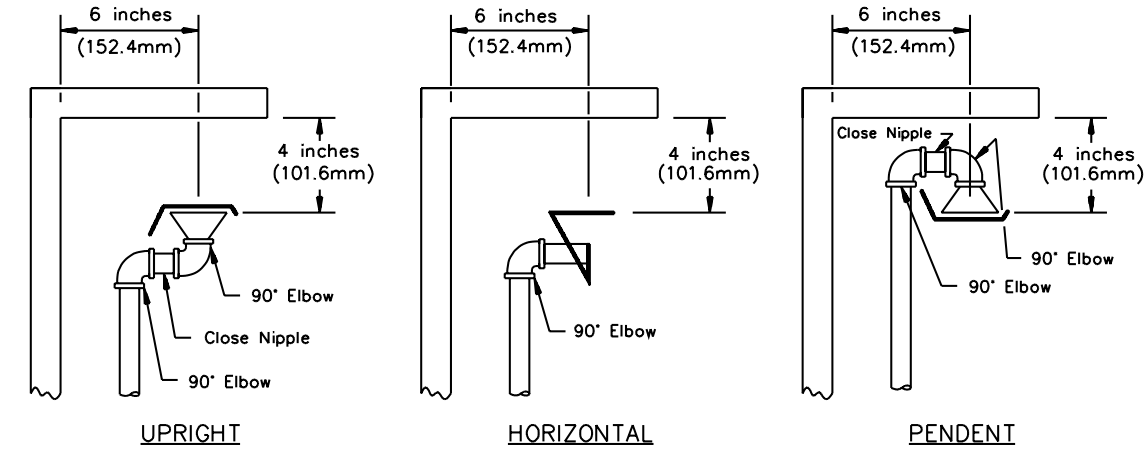
Figure 33.1
Sidewall sprinkler distribution test



NOTE: ALL PIPING 1 INCH (33.4mm OD) SCHEDULE 40



S2468B

33.3 Two sprinklers are to be installed below a ceiling in their intended installation position, each supplied with water through 1-inch piping in front of a 20-foot wide by 8-foot high (6.1- by 2.4-m) wall section. The sprinklers are to be attached to the 1-inch piping as follows:

a) Upright and pendent type – by means of a 90- degree elbow, 1-inch close nipple, and a 1-by 1-inch 90-degree elbow;

b) Horizontal type – by means of a 90-degree elbow.

The two sprinklers are to be installed with their deflectors 6 inches (152 mm) from the wall and spaced 10 feet (3.05 m) apart, with frame arms in a uniform direction. One hundred 1-foot (305-mm) square collection pans are to be located in a 10-by 10-foot (3.05- by 3.05-m) square, centered between the sprinklers and extending 2 to 12 feet (0.61 to 3.65 m) outward from the wall. The sprinkler deflectors are to be located 4 inches (102 mm) below a ceiling located 8 feet (2.4 m) above the floor. See Figure 33.1.

33.4 For 1.4, 1.9, 2.8, 4.2, and 5.6 nominal “K” factor sprinklers, the water flow rate is to be 15 gpm (0.95 L/s). For 8.0 nominal “K” factor sprinklers, the water flow rate is to be 21 gpm (1.3 L/s). In addition, sprinklers rated for pressures exceeding 175 psig (1.2 MPa) are to be tested at a flow rate corresponding to a pressure of 75 psig (517 kPa) less than the rated pressure.

33.4 revised January 24, 2000

33.5 Water is to be discharged for a minimum of 10 minutes. The water wetting the wall behind the sprinkler is to be collected, measured, and the percentage of the total discharge calculated. The water impinging on the back wall is to flow downward on the surface of a nonporous plastic material that is to be placed over the surface of the wall. The water is to be directed from the plastic into a row of collection pans on the floor adjacent to the wall. A baffle is to be placed over the pan to prevent direct impingement of water from the sprinkler. The amount collected in each pan is to be measured and recorded to determine the amount and uniformity of discharge.

34 350 Pound Wood Crib Fire Test

34.1 General

34.1.1 When tested as described in 34.2.1– 34.4.14 while discharging water at the flow rates as shown in Table 34.1; and for sprinklers having a rated pressure exceeding 175 psig (1.2 MPa), at a flow rate corresponding to a pressure of 75 psig (517 kPa) less than the rated pressure; four open sprinklers shall:

a) Limit the loss in weight of the wood crib to not more than 20 percent; and

b) Result in the ceiling temperature reduced to a value less than 530°F (295°C) above ambient within 5 minutes after start of water discharge. Additionally, from the time the temperature initially falls below 530°F above ambient to the end of the test, the ceiling temperature shall not exceed this value for more than three consecutive minutes and the average temperature for this period shall not exceed 530°F above ambient.

34.1.1 revised October 8, 1997

34.1.2 Sidewall, 1.4, 1.9, 2.8, and 4.2 nominal “K” factor, and extended coverage type sprinklers, intended for use in light hazard occupancies only, are not to be subjected to the 350 lb. Wood Crib Fire Test.

34.1.2 revised January 24, 2000

Table 34.1
Flows for 350 lb. wood crib fire test

Table 34.1 effective October 8, 1998

Sprinkler description	Spacing, feet	Test flow per sprinkler, GPM
Spray type, standard orifice	10 x 10	15 and 25
Spray type, large orifice	10 x 10	21 and 35
Sidewall, standard orifice	10 x 20	15 and 25
Sidewall, large orifice	10 x 20	21 and 35
Extended coverage sprinklers for ordinary hazard occupancies, upright and pendent	12 x 12	22 and 29
	14 x 14	30 and 39
	16 x 16	39 and 51
	18 x 18	49 and 65
	20 x 20	60 and 80

34.2 Test Method – spray upright, spray pendent, ceiling, dry, or recessed or extended coverage for ordinary hazard occupancies types

34.2.1 Four open sprinklers of the spray upright, spray pendent, spray ceiling type, or spray dry type are to be installed at the corners of a 10 by 10 foot (3.05 by 3.05 m) piping grid or at the spacings specified by the manufacturer for the Extended Coverage Sprinklers for Ordinary Hazard Occupancies in a vented test room having a smooth, flat, horizontal ceiling 15 feet, 9 inches (4.8 m) high. Sprinkler frame arms are to be parallel to the piping and the wood crib centered between the four sprinklers. For extended coverage sprinklers, an additional fire test is to be conducted at the maximum sprinkler spacing specified by the manufacturer, using the highest flow indicated in Table 34.1 for the applicable spacing, with the crib positioned in a location yielding the least amount of water collected during the Distribution Tests for Extended Coverage Sprinklers Intended for Ordinary Hazard Occupancies, Section 50. The test room is to be a minimum of 60 by 60 feet (18.3 by 18.3 m) square. The piping grid is to be connected to a water-supply piping system. See Figure 34.2.

34.2.1 effective October 8, 1998

34.2.2 When dry-type sprinklers are tested, they are to be of the shortest length produced by the manufacturer.

34.2.3 The deflectors of upright sprinklers are to be located 7 inches (178 mm) below the ceiling. The deflectors of pendent sprinklers are to be located 12 inches (305 mm) below the ceiling. Each ceiling sprinkler (flush, concealed, or recessed type) is to be mounted in the center of a 4 by 4 foot (1.2 by 1.2 m) ceiling section in accordance with the manufacturer's installation instructions.

34.3 Test method – sidewall types for ordinary hazard use

34.3.1 Four open sidewall sprinklers are to be installed at the corners of a 10 by 20 foot (3.05 by 6.1 m) piping grid with the deflectors located 7 inches (178 mm) for upright sprinklers, 9-1/2 inches (241 mm) for horizontal sprinklers, and 12 inches (305 mm) for pendent sprinklers from the ceiling in a vented test room having a ceiling 15 feet, 9 inches (4.8 m) high. Sprinklers located at the extremities of each 20 foot (6.1 m) dimensional line are to face each other and are to be set to discharge in an opposing pattern with the line forming the axis of the spray. The test room is to be a minimum of 60 by 60 feet square. The piping grid is to be connected to the water supply.

34.4 Test method – all types

34.4.1 The fire employed for these tests is to combine the use of a combustible liquid (heptane, see 34.4.9) torch and a crib of wood weighing approximately 350 pounds (159 kg).

34.4.1 revised July 9, 2001

34.4.2 The wood crib is to consist of layers of trade size 2- by 4-inch [nominal 1-1/2 by 3-1/2 inch (38.1 by 88.9 mm)], trade size 4- by 4- inch [nominal 3-1/2 by 3-1/2 inch (88.9 by 88.9 mm)] and trade size 4- by 6-inch [nominal 3-1/2 by 5-1/2 inch (88.9 by 138 mm)] kiln-dried spruce or fir lumber (moisture content 6 to 12 percent) having the configuration and support illustrated by Figure 34.1.

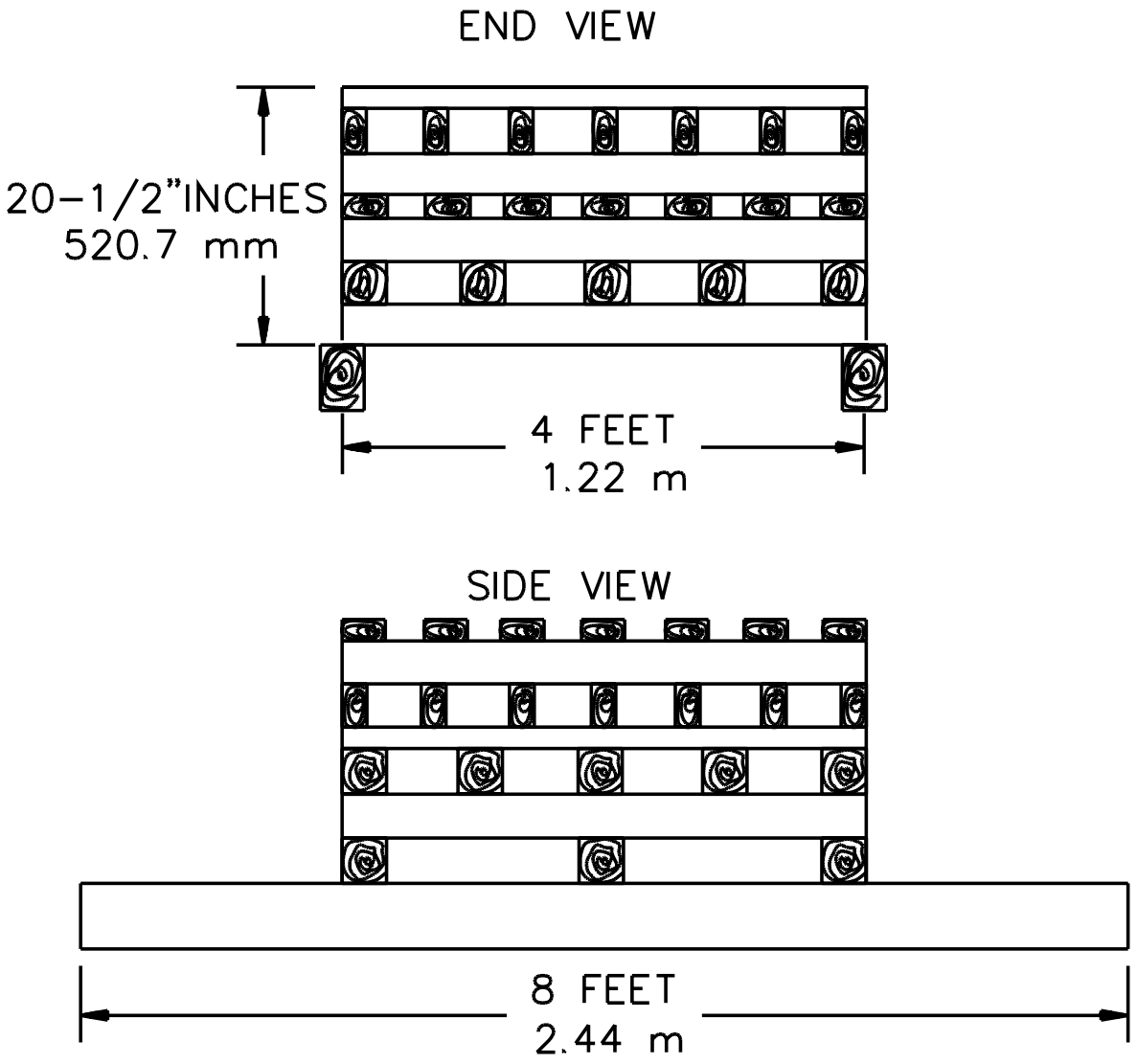
34.4.3 The alternate layers of lumber are to consist of the sizes specified in 34.4.2 of the lengths specified in Figure 33.1, and placed at right angles to the adjacent layers as illustrated in Figure 34.1. The individual wood members in each layer are to be evenly spaced from each other, and form a square crib, 4- by 4-feet (1.22- by 1.22-m) in area and 21-1/2 inches (546 mm) high, supported, in turn, by the two 8 foot (2.44 m) long, 4- by 6-inch (104- by 152-mm) stringers. The total crib weight is to be determined and recorded.

34.4.4 The crib is to be supported by a steel framework as illustrated in Figure 34.2, or the equivalent. The crib supports are to be located beyond the edges of a 6- by 8-foot (1.83- by 2.44-m) steel pan.

34.4.5 The top of the wood crib is to be 7-1/2 feet (2.29 m) below the deflectors of the test sprinklers and 7-1/2 feet above the floor of the room.

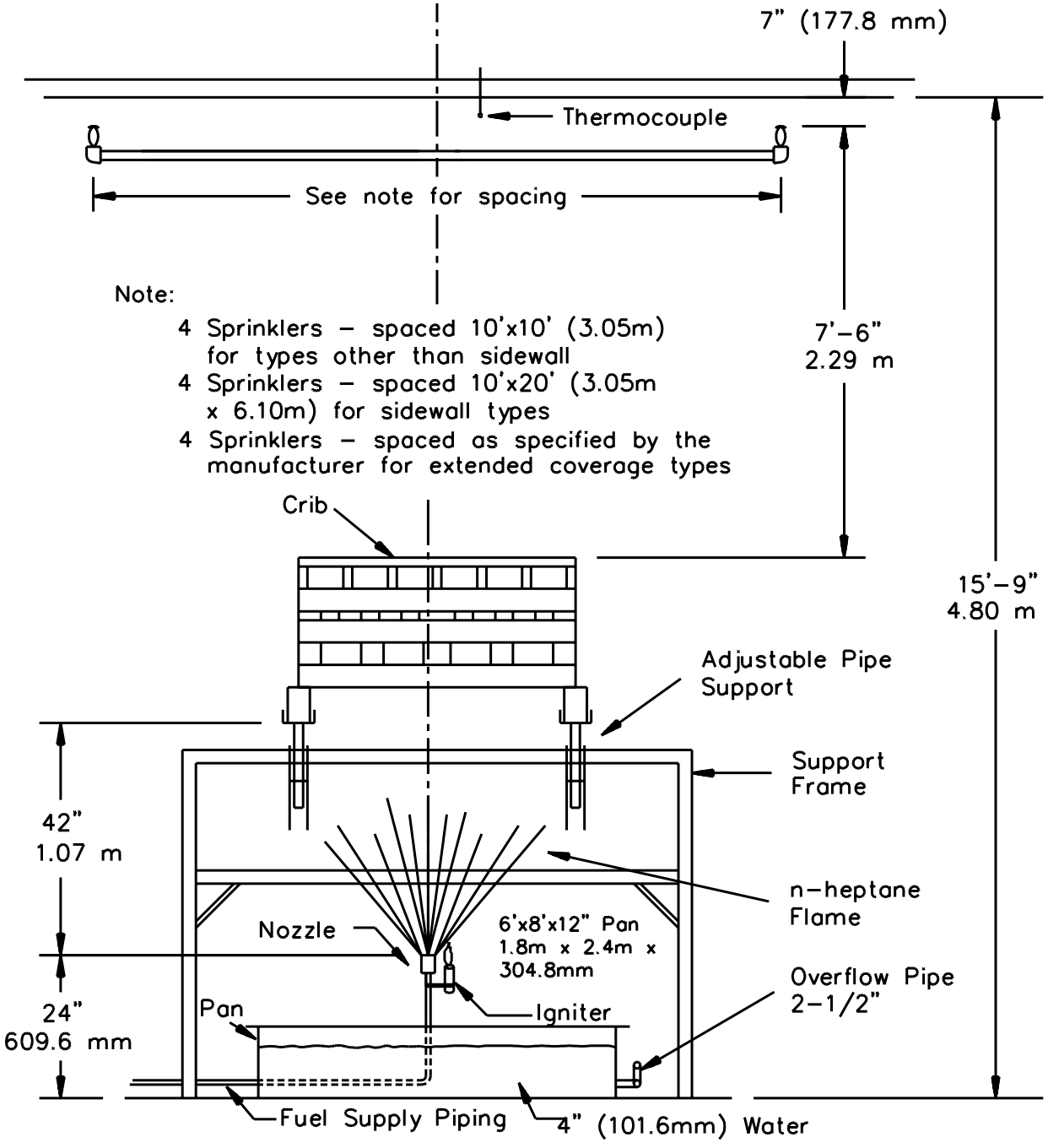
34.4.6 The steel pan is to be 6 by 8 feet (1.83 by 2.44 m) by 12 inches (305 mm) deep, constructed of steel not less than 3/16 inch (5.4 mm) thick. The top edges are to be reinforced by a continuous steel angle section. The pan is to be liquid-tight and is to be filled prior to test with water to a depth of 4 inches (102 mm). The pan is to be provided with a means for draining to maintain the 4 inch water level.

Figure 34.1
350 lb. Fire Test Crib



Quantity	Description of Material
2	4- by 6-inch trade size lumber, 8 feet long
13	4- by 4-inch trade size lumber, 4 feet long
28	2- by 4-inch trade size lumber, 4 feet long
Note: 1 inch = 25.4 mm 1 foot = 0.305 m	

Figure 34.2
Typical Fire Test Arrangement



34.4.7 At a location in the pan and directly under the vertical axis of the wood crib, an atomizing nozzle is to be placed and arranged to spray heptane vertically upward. The nozzle and its supply piping are to be arranged as shown by Figure 34.2. To prevent flameout, an igniter is to be located near the nozzle. The igniter shall be any convenient device that prevents flameout, such as a container partially filled with heptane.

34.4.8 The atomizing nozzle[a] is to form a hollow-spray pattern having an included angle of 75 degrees when atomizing heptane at the rate of 1 gallon per minute (0.06 L/s).

[a]A nozzle having these characteristics is the Catalog Number WS-15 Industrial Nozzle as produced by the Delavan Manufacturing Co., West Des Moines, Iowa 50265.

34.4.9 The heptane is to be commercial grade having the characteristics described below:

Distillation –

Initial Boiling Point – 90°C (194°F)

50 Percent – 93°C (199°F)

Dry Point – 96.5°C (208°F)

Specific Gravity (60°F/60°F) (15.6°C/15.6°C) – 0.719

Reid Vapor Pressure – 2.0 psi

Research Octane Rating – 60

Motor Octane Rating – 50

34.4.10 A means for supplying and metering the fuel is to be furnished.

34.4.11 The temperatures at the ceiling level are to be continuously recorded during the test, utilizing an unprotected No. 20 AWG (0.52 mm^2) chromel-alumel thermocouple centrally located above the test crib 2 inches (50.8 mm) from the ceiling. The relation of the thermocouple to the ceiling and the crib is to be as illustrated in Figure 34.2.

34.4.12 The fuel flow is to be started and the torch ignited immediately. The 30-minute test period is to begin when the torch is ignited. Water application is to be started after a minimum free-burning time of 1 minute or after a ceiling temperature of 1400°F (760°C) is attained, whichever occurs last. Thirty minutes after ignition, the fuel flow to the torch is to be stopped, and after any residual fire in the crib is extinguished, the water is to be turned off.

34.4.13 The crib is then to be dried and weighed. The drying is to be accomplished either by using an oven or by storing the crib for 7 days after the test. When the crib is held for 7 days prior to weighing, the crib is to be stored in a sheltered area. The values of the crib weight measured before the test (6 to 12 percent moisture content) and after drying are to be corrected to the value at 0 percent moisture before calculations are performed to determine compliance with the 20 percent weight loss requirement specified in 34.1.1.

34.4.14 The average temperature for the time interval between the time at which the ceiling temperature first falls below a temperature of 530°F (295°C) above initial ambient and the time at the end of the test is to be computed by comparing the area under the curve determined by the recorded ceiling temperatures with the area beneath a straight line drawn at the temperature point 530°F above initial ambient. The area beneath the curve of the recorded ceiling temperatures shall be the lesser of the two areas.

35 10-Day Corrosion Test

35.1 The external parts of an automatic sprinkler shall withstand an exposure to salt spray, hydrogen sulfide, and carbon dioxide-sulfur dioxide atmospheres when tested in accordance with 36.1.4 – 36.5.1 for 10 days each. Following the exposure:

a) The Sensitivity – Oven Heat Test is to be conducted on sprinklers other than QR recessed, QR concealed, QR-EC recessed and QR-EC concealed types, see 19.2.1 – 19.2.5;

b) The Sensitivity – Room Heat Test is to be conducted on QR recessed, QR concealed, QR-EC recessed and QR-EC concealed type sprinklers, see 19.3.1 – 19.3.5; and

c) The Response Test for Ordinary and Intermediate Temperature Rated Ceiling Type Sprinklers is to be conducted on standard response type ceiling sprinklers, see 19.3.1 – 19.3.5.

Each sample shall be operable, and the average time of operation shall not increase more than a 1.3 multiple when compared with the average time of operation of samples not subjected to the 10-Day Corrosion Test. During the corrosive exposure, the inlet thread orifice is to be sealed by a plastic cap after the sprinkler has been filled with de-ionized water.

35.2 A dry pendent or dry ceiling sprinkler that uses an operating assembly of the same type that has complied with the operation requirements specified in 35.1 shall be subjected to the plunge test specified in 35.3. After the heat-responsive element operates, all parts shall clear the waterway under an air pressure of 10 psig (69 kPa).

35.3 The plunge test is to be conducted in a full draft air oven that has been preheated to a temperature of 300 ±5°F (149 ±3°C) or a temperature of 100°F (55.6°C) higher than the marked temperature rating, whichever is higher. Each sprinkler is to be individually connected to a 10 psig (69 kPa) air supply and quickly placed in the oven in the pendent position.

36 30-Day Corrosion Test

36.1 General

36.1.1 The external parts of an automatic sprinkler having a corrosion-resistant coating or plating shall withstand an exposure to salt spray, hydrogen sulfide, and carbon dioxide-sulfur dioxide atmospheres when tested in accordance with 36.1.3 – 36.5.1 for 30 days. Following the exposure, the Sensitivity – Oven Heat Test, see 19.2.1 – 19.2.5, is to be conducted, and each sample shall be operable, and the average time of operation shall not increase more than a 1.3 multiple when compared to the average time of samples not subjected to the 30-Day Corrosion Test. During the corrosive exposure, the inlet thread orifice is to be sealed by a plastic cap after the sprinkler has been filled with de-ionized water.

36.1.2 A dry pendent or dry ceiling-type sprinkler that uses an operating assembly of the same type that has complied with the operation requirements specified in 36.1.1 shall be subjected to the plunge test specified in 35.3. After the heat responsive element operates, all parts shall clear the waterway under an air pressure of 10 psig (69 kPa). See 35.3.

36.1.3 Not more than 5 days, nor less than 1 day, after the exposure period, each sample sprinkler is to be subjected to the Sensitivity – Oven Heat Test, see 19.2.1 – 19.2.5 for determination of its operating time.

36.1.4 Three groups, each consisting of five sample sprinklers, are to be assembled. One group is to be exposed to 20 percent salt spray, the second to hydrogen sulfide, and the third to sulfur dioxide-carbon dioxide.

36.1.5 CAUTION – Hydrogen sulfide and sulfur dioxide are both toxic gases. Hydrogen sulfide gas is also flammable. Because of this, such gases must be stored, transferred, and used only with gastight systems. Adequate ventilation must also be provided to handle any accidental leakage. Presence of these gases is readily noticeable. Due to their unpleasant odor and irritant effect, they give warning of their presence.

36.2 20 Percent salt spray

36.2.1 The samples are to be supported vertically and exposed to salt spray (fog) as specified in Standard Practice for Operating Salt Spray (Fog) Testing Apparatus, ASTM B117-1995, except that the salt solution is to consist of 20 percent by weight of common salt (sodium chloride) and distilled water. 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 (35.0°C).

36.3 Samples for moist hydrogen sulfide air mixture test and moist carbon dioxide-sulfur dioxide air mixture test

36.3.1 The specimens intended for tests specified in 36.4.1 and 36.5.1 are to be supported vertically in a rectangular chamber (10 – 12 inches long, 8 – 10 inches wide, and 12 – 17 inches high) of glass provided with a glass cover having openings for gas inlet and outlet. The size of the test chamber is not critical and its dimensions are to be varied (even beyond those limits specified) to accommodate the number and size of the specimens to be tested.

36.4 Moist hydrogen sulfide air mixture

36.4.1 The samples are to be exposed to a moist hydrogen sulfide air mixture in a closed glass chamber. On five days out of every seven, an amount of hydrogen sulfide equivalent to 1.0 percent of the volume of the chamber is to be introduced into the chamber from a commercial gas cylinder, the volume required being measured with a flowmeter and timer. Prior to each introduction of gas, the remaining gas-air mixture from the previous day is to be thoroughly purged from the chamber. On the two days out of every seven that this does not occur, the chamber is to remain closed and no purging or introduction of gas is to be provided. During the exposure, the gas-air mixture is to be gently stirred by means of a small fan located in the upper middle portion of the chamber. A small amount of water (10 ml/0.003 m^3 of chamber volume) is to be maintained at the bottom of the chamber for humidity.

36.5 Moist carbon dioxide-sulfur dioxide air mixture

36.5.1 The samples are to be exposed to a moist carbon dioxide-sulfur dioxide air mixture in a closed glass chamber. On five days out of every seven, an amount of carbon dioxide equivalent to 1.0 percent of the volume of the chamber, plus an amount of sulfur dioxide equivalent to 1.0 percent of the volume of the chamber, are to be introduced. Prior to each introduction of gas, the remaining gas-air mixture from the previous day is to be thoroughly purged from the chamber. On the two days out of every seven that this does not occur, the chamber is to remain closed and no purging or introduction of gas is to be provided. A small amount of water (10 ml/0.003 m^3 of chamber volume) is to be maintained at the bottom of the chamber for humidity.

37 90-Day Moist Air Test

37.1 An automatic sprinkler shall withstand an exposure to high temperature-humidity in accordance with 36.2 for a period of 90 days. Following the exposure, each test sample shall operate at a service pressure not exceeding 7 psig (48 kPa) within 5 seconds after operation of the heat responsive element.

37.2 Five samples are to be installed on a pipe manifold which contains water and the entire manifold is to be placed in a temperature-humidity chamber for 90 days. The temperature of the chamber is to be 203 ±2°F (95 ±1°C) and the humidity is to be 98 ±2 percent. The sprinkler samples for the moist air test are to have heat responsive elements that have a temperature rating not less than 212°F (100°C) to withstand the elevated temperature.

37.3 After the exposure, each sample is to be installed on piping and supplied with water at a service pressure of 7 psig (48 kPa). Each sprinkler is then to be activated by exposing the heat responsive element to a uniform application of heat. The operating parts intended to be released from the sprinkler assembly shall be thrown clear of the frame and deflector within 5 seconds after operation of the heat responsive element.

38 Stress-Corrosion Cracking Of Brass Sprinkler Parts Test

38.1 A sprinkler having brass parts shall:

a) Show no evidence of cracking, delamination, or degradation; or

b) Perform as intended,

after being subjected for 10 days to a moist ammonia exposure as described in 38.2 and 38.3. When the application of a 175 psig (1.21 MPa) water pressure to the inlet of the sprinkler increases the assembly load by more than 10 percent, the additional load is to be applied during the moist ammonia-air mixture exposure specified in 38.2 and 38.3.

38.2 Five samples are to be degreased and then exposed for 10 days to a moist ammonia-air mixture maintained in a glass chamber 12 ±1 by 12 ±1 by 12 ±1 inches (304.8 ±25.4 by 304.8 ±25.4 by 304.8 ±25.4 mm) having a glass cover.

38.3 A small amount of aqueous ammonia having a specific gravity of 0.94 is to be maintained in the bottom of the chamber, 1-1/2 (+1/2, -0) inches [(38.1 mm) (12.7 mm, -0 mm)] below the bottom of the samples. The moist ammonia-air mixture in the chamber is to be maintained at atmospheric pressure with the temperature constant at 93 ±2°F (34 ±1°C).

38.4 After the exposure period, the test samples are 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. Operating parts exhibiting degradation as a result of the test exposure described in 38.2 and 38.3 shall withstand, without leakage, a hydrostatic test pressure of 175 psig (1.21 MPa) or one equivalent to their maximum design pressure, whichever is greater, for 1 minute, and operate at 7 psig (48 kPa) when exposed to a uniform application of heat. When the samples have any cracking, delamination, or degradation of nonoperating parts as a result of the test exposure, they shall withstand a flowing pressure of 175 psig for 30 minutes.

39 Stress-Corrosion Cracking Of Stainless Steel Sprinkler Parts Test

39.1 Austenitic stainless steel parts of a sprinkler shall show no evidence of cracking, delamination, or degradation, or shall demonstrate intended performance, after being subjected to boiling magnesium chloride solution. The exposure to the solution is to be 150 hours for sprinklers intended for use in noncorrosive atmospheres only, and 500 hours for sprinklers intended for use in corrosive atmospheres. See 39.2 – 39.7.

39.2 Five samples are to be degreased prior to being exposed to the magnesium chloride solution.

39.3 Parts used in sprinklers are to be placed in a 500-milliliter 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±2°F (150 ±1°C). The parts are to be unassembled, that is, not contained in a sprinkler assembly. The exposure is to last for 150 or 500 hours, as specified in 39.1.

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

39.5 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. Test samples exhibiting degradation are to be tested as described in 39.6 or 39.7, as applicable. Test samples not exhibiting degradation comply with the requirements and shall not be tested further.

39.6 Operating parts exhibiting degradation are to be further tested as follows. Five new sets of parts are to be assembled in sprinkler frames made of materials that do not alter the corrosive effects of the magnesium chloride solution on the stainless steel parts. These test samples are to be degreased and subjected to the magnesium chloride solution exposure specified in 39.3. Following the exposure, the test samples shall withstand, without leakage, a hydrostatic test pressure of 175 psig (1.2 MPa) for 1 minute, and then operate at 7 psig (48 kPa) – see Operation – Lodgement Test, Section 20.

39.7 Nonoperating parts exhibiting degradation are to be further tested as follows. Five new sets of parts are to be assembled in sprinkler frames made of materials that do not alter the corrosive effects of the magnesium chloride solution on the stainless steel parts. These test samples are to be degreased and subjected to the magnesium chloride solution exposure specified in 39.3. Following the exposure, the test samples shall withstand a flowing pressure of 175 psig (1.21 MPa) for 30 minutes without separation of permanently attached parts.

40 Exposure Tests On Sprinklers Incorporating Polymeric Gaskets Or ″O″ Ring Seals

40.1 General

40.1.1 An automatic sprinkler that incorporates a polymeric material to effect the closure of the orifice shall not leak, where specified, and shall operate at a service pressure not exceeding 7 psig (48 kPa) after being exposed, in separate groups of samples, to the exposures specified in 40.2 – 40.6.

Revised 40.1.1 effective October 8, 1998

40.2 Corrosive exposures

40.2.1 Three groups, each consisting of five samples, are to be assembled. One group is to be exposed to 20 percent salt spray as specified in 36.2.1, the second to hydrogen sulfide as specified in 36.3.1 and 36.4.1, and the third to carbon dioxide-sulfur dioxide as specified in 36.5.1. Each exposure period is to be 30 days.

40.2.1 revised October 8, 1997

40.2.2 Following the exposure, the operating parts in contact with the polymeric material of each test sample shall operate within 5 seconds after being exposed to a service pressure not exceeding 7 psig (48 kPa).

Revised 40.2.2 effective October 8, 1998

40.3 Temperature cycling exposure

40.3.1 Five samples are to be exposed to ten temperature cycles, each comprised of a 24-hour exposure to a low temperature of minus 40°F (minus 40°C) and a 24-hour exposure to a high temperature as specified in Table 23.1.

40.3.2 Following the exposures, each sprinkler is to be installed on piping and supplied with water at a service pressure of 7 psig (48 kPa). Each sprinkler is then to be operated by exposing the heat responsive element to a uniform application of heat. The operating parts in contact with the polymeric material of each test sample shall operate as intended within 5 seconds.

Revised 40.3.2 effective October 8, 1998

40.4 Hydrocarbon exposure followed by moist air exposure

40.4.1 Two groups, each consisting of five samples, are to be assembled. One group is to have the sprinkler inlet exposed to a liquid mixture of saturated hydrocarbon chains ranging from C12 to C17, mixed in equal parts by weight. The second group is to have the sprinkler inlet exposed to a solid wax mixture of saturated hydrocarbon chains ranging from C18 to C25, mixed in equal parts by weight. The wax mixture has a melting point of 129 ±2°F (54 ±1°C). A hydrocarbon material equal to or greater than that required to completely cover the water seal area or 0.025 ml (approximately 0.1g) is to be placed in the sprinkler inlet in a manner to expose the polymeric seal assembly to the hydrocarbon. The samples using the wax mixture shall be warmed to 140 ±5°F (60 ±3°C) to liquefy the material for even distribution over the seal area. Both groups of sprinklers are then to be conditioned at 70 ±10°F (21 ±5.6°C) for a minimum of 72 hours. After these exposures, the samples are then to be subjected to the 90 day moist air test specified in Section 37, 90-Day Moist Air Test, with the sprinkler installed in the pendent position and the hydrocarbon mixtures left in the inlet.

40.4.1 revised September 6, 2000

40.4.2 After these test exposures, each sample is to be hydrostatically pressurized at 7 psig (48 kPa) and examined for leakage for a period of 1 minute, and then operated by exposing the heat responsive element to a uniform application of heat.

Added 40.4.2 effective October 8, 1998

40.5 Hydrocarbon exposure followed by water immersion exposure

40.5.1 Two groups, each consisting of five samples, are to be assembled and subjected to the hydrocarbon exposures described in 40.4. After the minimum 72 hour hydrocarbon exposure, the samples are to be installed on a manifold and hydrostatically pressurized to a pressure value of 25 psig less than the rated pressure and immersed for 90 days in tap water maintained at a temperature of 87 ±2°C (189 ±3.6°F). After 30 and 60 days, the hydrostatic pressure is to be released and then repressurized to a pressure value of 25 psig less than the rated pressure.

Added 40.5.1 effective October 8, 1998

40.5.2 After these exposures, each sample is to be hydrostatically pressurized and operated at 7 psig (48 kPa) and examined for leakage for a period of 1 minute, and then operated by exposing the heat responsive element to a uniform application of heat.

Added 40.5.2 effective October 8, 1998

40.6 Exposure to antifreeze solutions

40.6.1 Four groups, each consisting of five samples, are to be assembled. The samples are to be installed onto a manifold. The manifold is to be partially filled, such that the inlet of each sample is exposed to the following antifreeze solutions (by volume) for 90 days at a temperature of 87 ±2°C (189±3.6°F):

a) One group exposed to a 60 percent diethylene glycol/40 percent tap water mixture;

b) One group exposed to a 53 percent ethylene glycol/47 percent tap water mixture;

c) One group exposed to a 60 percent propylene glycol/40 percent tap water mixture; and

d) One group exposed to a 70 percent glycerine/30 percent tap water mixture.

Added 40.6.1 effective October 8, 1998

40.6.2 After these exposures, each sample is to be hydrostatically pressurized at 7 psig (48 kPa) and examined for leakage for a period of 1 minute, and then operated by exposing the element to a uniform application of heat.

Added 40.6.2 effective October 8, 1998

40A Dry-Type Sprinkler Deposit Loading Test

40A.1 After exposure to a carbon dioxide-sulfur dioxide atmosphere in accordance with 40A.2 – 40A.6 for 30 days, the water seal assembly and internal components of a dry-type sprinkler shall function as intended within 5 seconds after 7-psig (48-kPa) air pressure is applied to the sprinkler inlet.

Added 40A.1 effective January 9, 2003

40A.2 After the carbon dioxide-sulfur dioxide exposure, the samples are to be dried at 120 ±5°F (49 ±2°C) in an automatically-controlled, circulating-type, constant temperature oven for not less than 24 hours or more than 72 hours prior to being operated at 7 psig (48 kPa) with air.

Added 40A.2 effective January 9, 2003

40A.3 Two groups, each consisting of five sample sprinklers in the ordinary temperature rating and the minimum length to be produced, are to be assembled. If lubricant is required to facilitate sprinkler assembly, the minimum amount required to assemble the test samples shall be used. One group is to be exposed with the sprinkler in the vertical position with the inlet up and the second group with the sprinkler inlet down.

Added 40A.3 effective January 9, 2003

40A.4 The samples are to be exposed to a moist carbon dioxide-sulfur dioxide air mixture in a closed chamber maintained at 93 ±2°F (34 ±1°C). The samples are to be supported in a manner to permit the internal and external sprinkler parts to be exposed to the gases, such as by placing test samples on polymeric light diffuser trays with nomimal 0.5 by 0.5 inch openings. All test samples shall be supported at only one elevation level within the chamber. On five days out of every seven, an amount of carbon dioxide equivalent to 1.0 percent of the volume of the chamber, plus an amount of sulfur dioxide equivalent to 1.0 percent of the volume are to be introduced. Prior to each introduction of gas, the remaining gas-air mixture from the previous day is to be thoroughly purged from the chamber. On the two days out of every seven that this does not occur, the chamber is to remain closed and no purging or introduction of gas is to be provided. A small amount of water (10 ml/0.003 $m^3$of chamber volume) is to be maintained at the bottom of the chamber for humidity. This water is to be replaced weekly.

Added 40A.4 effective January 9, 2003

40A.5 After exposure to the carbon dioxide-sulphur dioxide air mixture, each sample is to be dried as specified in 40A.2. Each sample is then to be stored at 70 ±5°F (21 ±3°C) prior to installation onto piping in the pendent position and supplied with air at a service pressure of 7 psig (48 kPa). Each sprinkler is then to be activated by exposing the heat responsive element to a uniform application of heat or by removing the heat responsive element if it is degraded by the moist carbon dioxide-sulfur dioxide exposure. The water seal assembly and other internal parts shall clear the waterway as intended.

Added 40A.5 effective January 9, 2003

40A.6 CAUTION – Sulfur dioxide is a toxic gas. This gas must be stored, transferred, and used only with gastight systems. Adequate ventilation must also be provided to handle leakage. Presence of this gas is readily noticeable. Due to its unpleasant odor and irritant effect, it gives warning of its presence.

Added 40A.6 effective January 9, 2003

40B Dezincification Test of Brass Parts

40B.1 General

40B.1.1 Sprinkler parts that are made of a copper alloy containing more than 15 percent zinc and normally exposed to system water shall not exhibit the following after exposure to a copper chloride solution for 144 hours:

a) An average dezincification depth exceeding 100 µm (0.0039 inch); and

b) An individual reading of dezincification depth exceeding 200 µm (0.0079 inch).

Added 40B.1.1 effective January 9, 2003

40B.2 Reagent

40B.2.1 A test solution is to be prepared by dissolving 12.7 g (0.028 pound) of copper (II) chloride dihydrate ($CuCl_2 2H_20$) in distilled water and then making up the volume to 1000 ml (0.26 gallon). Fresh solution is to be used for each test.

Added 40B.2.1 effective January 9, 2003

40B.3 Test Pieces

40B.3.1 Three test pieces are to be taken from the sprinkler part. These pieces are to be cut in such a way, for example by sawing and grinding with light pressure, that the properties of the materials are unaffected. The area of each test piece to be exposed shall be approximately 100 mm^2(0.155 square inch).

Added 40B.3.1 effective January 9, 2003

40B.3.2 Each test piece is to be embedded in a thermoset resin having minimal shrinkage characteristics and the test surface ground using wet abrasive paper, finishing with 500 grade or finer. The test surfaces are to be cleaned with ethanol prior to testing.

Added 40B.3.2 effective January 9, 2003

40B.4 Method

40B.4.1 Each test piece is to be placed in the middle of the beaker containing the copper (II) chloride solution so that the test surface is vertical and at least 15 mm (0.59 inch) above the bottom of a glass beaker covered with suitable plastic foil, for example polyethylene, secured with elastic thread or another method of sealing using non-metallic compound. A total of 250 ml (+50 ml, -10 ml) [0.066 gallon (+0.013 gallon, -0.0026 gallon)] of the copper (II) chloride solution is required per 100 mm^2(0.155 square inch) of exposed surface of the test piece.

Added 40B.4.1 effective January 9, 2003

40B.4.2 The beaker containing the test piece is to be placed in the thermostatically controlled oven or oil bath with the temperature maintained at 75 ±2°C (167 ±3°F). The test piece is to be exposed continuously for 144 hours. At the end of this period, they are to be removed from the beaker, washed in water, rinsed in the ethanol, and allowed to dry.

Added 40B.4.2 effective January 9, 2003

40B.4.3 Microscopic examination of the test piece is to be conducted as soon as possible after the exposure. If the test pieces are stored before microscopic examination, they are to be kept in a desiccator. Each test piece is to be sectioned at right angles to the exposed test surface, and the remaining thermoset resin attached to the section is to be removed. The cross-sectioned piece is then to be re-embedded in a thermoset resin having minimal shrinkage, and the area to be viewed is to be ground and polished for microscopic examination. The total length of section through the exposed surface is not to be less than 5 mm (0.2 inch). If the dimensions of the test piece make this impossible, the section is to be taken to provide the maximum possible total length.

Added 40B.4.3 effective January 9, 2003

40B.4.4 The dezincification depth is to be made at five evenly spaced locations and the average calculated. The dezincification depth is to be measured from the post exposed test surface and is not to include the sample edge. The maximum dezincification is to be recorded. Magnification is to be used to provide the greatest accuracy of measurement.

Added 40B.4.4 effective January 9, 2003

41 Vacuum Test

41.1 A sprinkler incorporating elastomeric components used to provide a water seal at the sprinkler orifice shall not be damaged and shall comply with the Leakage Test, Section 14, following exposure to a vacuum as specified in 41.2.

41.2 Five samples are to be installed on a manifold and subjected to a vacuum of 18 inches of mercury (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, Section 14.

42 Elastomeric Parts Test

42.1 An elastomeric part used to provide a seal shall have the following properties when tested as specified in the Standard for Gaskets and Seals, 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. Also, the maximum compression set shall be 25 percent. The maximum service temperature used to determine the oven time and temperature for oven aging is 60°C, unless the product is designated for use at a higher temperature.

42.2 The Standard for Gaskets and Seals, 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.

43 Freezing Test

43.1 Following exposure to the freezing conditions described in 43.2, a sprinkler shall either operate, shall leak at low pressure, or shall not sustain any damage when water pressure is applied and shall comply with the requirements in Leakage Test, Section 14 and in Sensitivity Test, Section 19.

43.2 Five sample sprinklers are to be individually connected to one end of a 4 inch (102 mm) long, 1 inch nominal size schedule 40 pipe. Each pipe is to be completely filled with water and exposed to an atmosphere of minus 20 ±10°F (minus 29 ±5°C) for 24 hours. Following the exposure, the samples are to be visually examined. When no damage or evidence of operation is noted, the samples are then to be checked to determine whether they leak at a pressure of 7 psig (48 kPa). When they do not leak at a pressure of 7 psig, the samples shall then comply with the requirements in Leakage Test, Section 14, and Sensitivity Test, Section 19. The test is to be repeated when test apparatus, other than a sprinkler, fractures due to the freezing.

44 Fire Test for Extended Coverage Sprinklers Intended for Light Hazard Occupancies

44.1 General

44.1.1 When tested as described in 44.2.1 – 44.4.9, an extended coverage sprinkler for light-hazard occupancies shall limit the average loss of weight of three wood cribs to not more than 35 percent.

44.1.2 The fire test is to be conducted in a room having the maximum dimensions intended for the sprinkler as specified by the manufacturer.

44.1.3 Recessed or concealed sprinklers with vented escutcheons are to be installed in a manner that does not inhibit air flow through the escutcheon (unblocked).

44.2 Test method – sidewall type

44.2.1 For a sidewall type sprinkler intended for installation at distances from a smooth (unobstructed) ceiling between 4 and 6 inches (152 mm), one sprinkler is to be installed on a wall with the deflector located 4 inches (102 mm) below a smooth (unobstructed), horizontal ceiling, as illustrated in Figure 44.1. For a sidewall type sprinkler intended for installation at distances below the ceiling exceeding 6 inches, two series of tests are to be conducted, one with the sprinkler installed 4 inches below the ceiling and a second test series with the sprinkler installed at the maximum distance below the ceiling specified by the manufacturer. A sidewall type sprinkler intended for use with obstructed ceilings, such as those ceilings having beams, is to be similarly installed, except that the obstructions specified by the manufacturer are to be incorporated into the ceiling. The base of a horizontal type sprinkler is to be installed adjacent to the wall. The deflector of an upright or pendent type sidewall sprinkler is to be mounted at the minimum clearance from the wall specified by the manufacturer. A sidewall type sprinkler is to be installed using a 10-inch (254-mm) long, 1-inch diameter nipple with reducing coupling installed with axis perpendicular to the wall. See Figure 44.1.

44.3 Test method – ceiling, pendent, or upright types

44.3.1 A sprinkler of the ceiling, pendent, or upright type is to be installed in its intended installation position with the deflector 10 inches (254 mm) below the ceiling, unless specifically designed for other positions (such as recessed or ceiling type installations). See Figure 44.1.

44.4 Test method – all types

44.4.1 Water distribution measurements are to be conducted in an enclosed room with an open sprinkler discharging water at the minimum flow rate and maximum area of coverage specified by the manufacturer. The minimum flow rate is to be not less than a minimum water density of 0.1 gallon per minute per square foot (0.68 L/s/m^2) for the specified coverage area. For sprinklers rated at a pressure exceeding 175 psig (1.2 MPa), tests are to be conducted using a flow rate corresponding to a pressure of 75 psig (517 kPa) less than the rated pressure. Water collection pans that are 12 inches (305 mm) square, and 12 inches deep with a lip on one edge, are to be located on the floor of the enclosed room in the areas of the 11 crib locations as shown in Figure 44.2. The distribution data are to be recorded and used in determining the specific positions of the wood cribs as required for the second and third fire tests specified in 44.4.2.

44.4.1 revised October 8, 1997

44.4.2 A series of three fire tests are to be conducted at each flow rate using automatic sprinklers. For the first fire test, a wood crib as specified in 44.4.4 – 44.4.6 is to be located at Crib Location 1 of the test enclosure, see Figure 44.2. For the second fire test, the wood crib is to be located at Crib Location 2, 3, 4, 5, 6, or 7, see Figure 44.2, whichever location had the least amount of water collected during the distribution determinations. However, when Crib Location 5, 6, or 7 had the least amount of water collected then:

a) A sprinkler other than a sidewall type is to be rotated 180 degrees and the crib placed in Crib Location 1, 3, or 4, whichever is opposite the crib location that had the least amount of water collected; and

b) A sidewall type sprinkler is to be installed on the wall near Crib Location 2.

44.4.2 revised October 8, 1997

Figure 44.1
Piping arrangements for fire test for extended coverage sprinklers for light hazard occupancies

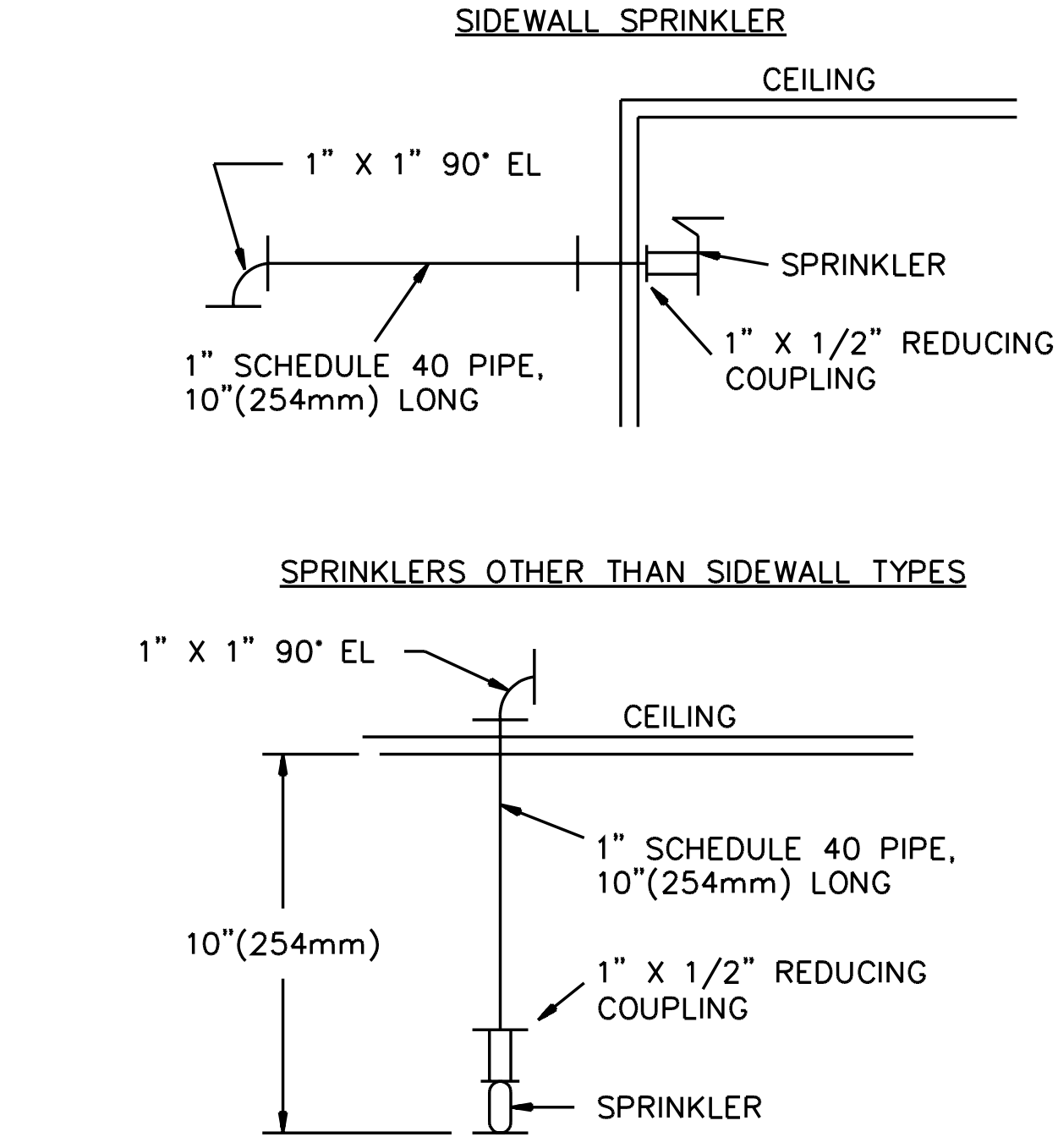
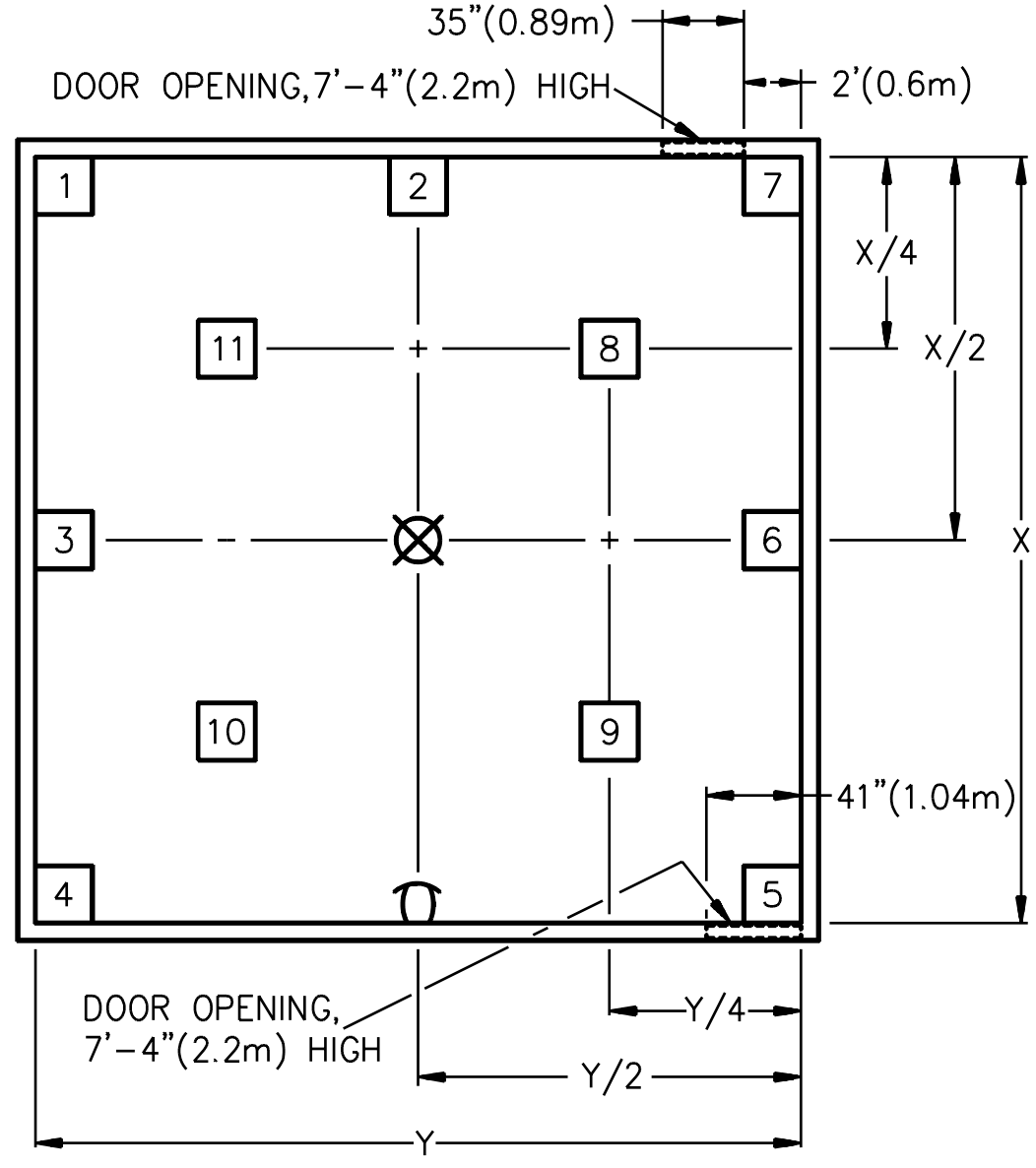


Figure 44.2
Location of fire test cribs for extended coverage sprinklers intended for light hazard occupancies

Figure 44.2 revised May 25, 1999



⊗ – SPRINKLER OTHER THAN SIDEWALL TYPE (WHEN OTHER THAN SIDEWALL TYPE IS BEING TESTED)

∩ – SIDEWALL TYPE SPRINKLER (WHEN SIDEWALL TYPE IS BEING TESTED)

□ – POSSIBLE CRIB LOCATION (SEE TEXT FOR SPECIFIC LOCATION DETERMINATIONS)

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44.4.3 For the third fire test, the wood crib is to be located in the center of one of the four quadrants of the test room (see Figure 44.2, Crib Location 8, 9, 10, or 11), whichever had the least amount of water collected during the distribution determination. However, when Crib Location 8 or 9 had the least amount of water collected, then:

a) A sprinkler other than a sidewall type is to be rotated 180 degrees and the fire placed in Crib Location 10 or 11, whichever is opposite the crib location that had the least amount of water collected; and

b) A sidewall type sprinkler is to be installed on the wall near Crib Location 2.

44.4.4 The wood crib is to be dimensioned 20 by 20 by 15 inches high and weigh 33 ±2 pounds-mass (15 ±1 kg).

44.4.5 The wood crib is to consist of ten alternate layers of five trade size 2- by 2-inch [nominal 1-1/2- by 1-1/2-inch (38.1- by 38.1-mm)] kiln-dried spruce or fir lumber 20 inches (508 mm) long. The alternate layers of the lumber are to be placed at right angles to the adjacent layers. The individual wood members in each layer are to be evenly spaced along the length of the previous layer of wood members and stapled to the adjacent members.

44.4.6 After the wood crib is assembled, it is to be conditioned at a temperature of 120 ±10°F (49 ±5°C) for not less than 16 hours. Following the conditioning, the moisture content of the crib is to be measured with a probe type moisture meter. The moisture content of the crib at any measurement location is not to exceed 5 percent prior to weighing the crib for the fire test.

44.4.7 For each test, the crib is to be placed on four bricks, one at each corner of the crib, that are contained in a 21 by 21 by 4 inch (533 by 533 by 102 mm) deep steel pan filled with 1/4 gallon (0.95 L) of heptane on a 1-inch (25.4 mm) layer of water. When the crib position is in a corner, the edge of the crib is to be positioned 1/2 inch (12 mm) from both walls.

44.4.8 The test room enclosure and sprinkler sample are to be maintained at a temperature of 75 ±15°F (24 ±8°C) prior to each test. The room is not to have provisions for ventilation other than that provided by the two door openings shown in Figure 44.2.

44.4.9 The water flow for the sprinkler is to be preset for the flow rate specified in 44.4.1. The test room doors are to be fully opened. The heptane is to be ignited. The test is to be conducted for 10 minutes after the ignition of the heptane. Ten minutes after ignition, the water for the sprinkler is to be turned off. When the fire in the crib has not been extinguished, it is to be carefully extinguished to prevent further destruction of the crib. The crib is to be removed from the test enclosure and is to be conditioned at a temperature of 120 ±10°F (49 ±5°C) for not less than 16 hours. Following the conditioning, the moisture content of the crib is to be measured with a probe type moisture meter. The moisture content of the crib at any measurement location is not to exceed 5 percent prior to weighing the crib to determine the crib weight loss.

44.4.9 revised October 8, 1997

45 Wall Wetting Test for Extended Coverage Sprinklers Intended for Light Hazard Occupancies

45.1 When tested as described in 45.2 – 45.4, and installed as specified by the manufacturer, each sprinkler shall wet the entire area of the wall surfaces of the test room to a minimum height of 30 inches (762 mm) above the floor.

45.2 The wall wetting tests are to be conducted in an enclosed room having the maximum dimensions intended for the sprinkler as specified by the manufacturer and a ceiling 8 feet (2.4 m) high.

45.3 Sidewall type sprinklers are to be installed at the greatest intended distance from the wall and at the minimum and maximum intended distance below the ceiling. The piping configuration shown in Figure 44.1 is to be used.

45.4 The manufacturer's specified minimum water flow rate is to be used. For sprinklers having a pressure rating greater than 175 psig (1.2 MPa), a flow rate corresponding to a pressure of 75 psig (517 kPa) less than the rated pressure is to be used. The water is to flow for 1 minute. After 1 minute of water flow, the flow is to be discontinued and each of the four walls examined to determine whether they are continuously wet from the floor to at least 30 inches (762 mm) above the floor.

45.4 revised October 8, 1997

46 Evaporation Test For Sprinkler Coatings

46.1 When tested as specified in 46.3, a protective coating of a sprinkler such as wax or other material shall not shrink, harden, crack, or flake.

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46.2 When tested as specified in 46.3, the loss of volatile material in a protective coating of a sprinkler shall not exceed 5 percent of the weight of the original sample.

46.3 A 50 milliliter sample of the protective coating is to be placed in a metal or glass cylindrical container having a flat bottom, an inside diameter of 55 millimeters, and an inside height of 35 millimeters. The container, without any lid, is to be placed in an automatically controlled, circulating-air, constant-ambient-temperature oven. The oven temperature is to be controlled as described in High Temperature – Test for Coated Sprinklers, Section 24. The test is to be conducted for 90 days. During the test, the sample is to be removed from the oven at 7 day intervals and allowed to cool for not less than 2 nor more than 4 hours. During this cooling time, the sample is to be examined for evidence of shrinking, hardening, cracking, or flaking. The sample is to be weighed before and after the 90 day exposure to determine loss of volatiles.

47 Cycling Tests For Flow Control (FC) Sprinklers

47.1 Operational cycling test

47.1.1 An FC sprinkler shall operate as intended for 10,000 cycles when tested as described in 47.1.2. Following the 10,000 cycles of operation the sprinkler shall comply with the requirement in 14.1, except that slight weeping is not prohibited. Slight weeping is defined as leakage not exceeding 20 milliliters per minute.

47.1.2 The sprinkler is to be installed in a test fixture and supplied with water at a pressure of 40 ±5 psig (276 ±49 kPa). Heat is to be applied to the sprinkler until it operates and attains the fully open position. The heat application then is to be discontinued and the heat sensing element permitted to cool until the sprinkler closes. This procedure is to be repeated until the specified number of test cycles is completed. The interval between each closing of the sample and reapplication of the heat is not to be greater than 60 seconds.

47.2 Cycling after water exposure test

47.2.1 An FC sprinkler that is continuously exposed to water shall operate as intended for 1000 cycles when tested as described in 47.1.2, after being immersed for 14 days in distilled water at a temperature between 203 and 212°F (95 to 100°C).

47.3 Contaminated-water cycling test

47.3.1 An FC sprinkler shall show no evidence of clogging when subjected to 1000 cycles as described in 47.1.2 using water that has been contaminated in accordance with 47.3.2. Following the 1000 cycles, the sprinkler shall comply with the requirements in 14.1, except that slight weeping is not prohibited. Slight weeping is defined as leakage not exceeding 20 milliliters per minute.

47.3.2 The water used during the cycling specified in 47.3.1 is to consist of 15 gallons (0.06 m^3) of tap water into which has been mixed 1.584 kilograms of contaminants which sieve as described in Table 47.1. The solution is to be continuously agitated during the test.

Table 47.1
Contaminant for contaminated-water cycling test

Sieve designation[a]	Nominal sieve opening, inch	Grams of contaminant (±5 Percent)		
		Pipe scale	Top soil	Sand
No. 25	0.0278	–	456	200
No. 50	0.0117	82	82	327
No. 100	0.0059	84	6	89
No. 200	0.0029	81	–	21
No. 325	0.0017	153	–	3
	Total	400	544	640

[a] Sieve designations correspond with those specified in the Standard Specification for Wire-Cloth Sieves for Testing Purposes, ASTM E11-95. Cenco-Meinzer sieve sizes 25 mesh, 50 mesh, 100 mesh, 200 mesh, and 325 mesh, corresponding with the number designation in the table, have been found to comply with ASTM E11-95.

48 Piled Stock Fire Test For Flow (FC) Control Sprinklers

48.1 When an FC sprinkler is tested under the conditions described in 48.2 – 48.12, the water discharge shall:

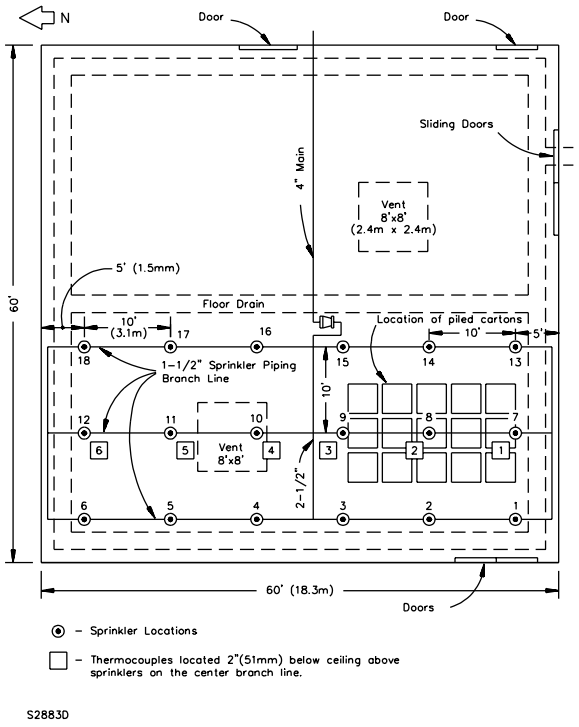
a) Limit the loss in weight of corrugated cartons (see 48.7), within 45 minutes of the start of the test, to not more than 50 percent.

b) Result in the ceiling temperature being reduced to a value less than 530°F (295°C) above ambient within 5 minutes after start of water discharge.

c) Result in the ceiling temperature not exceeding 530°F for more than three consecutive minutes and the average temperature not exceeding 530°F from the time the temperature initially falls below 530°F above ambient to the end of the test.

48.2 The test room is to be 60 by 60 feet square and have a ceiling 15 feet, 9 inches (4.8 m) high. The test room is to be vented and have provision for drainage of sprinkler discharge. See Figure 48.1.

Figure 48.1
Location of FC sprinklers and piled cartons



48.3 Eighteen sprinklers are to be installed over half of the test room by use of a sprinkler grid consisting of three 1-1/2-inch branch lines that are looped on both ends. Each branch line is to be individually supplied from a 2-1/2 inch cross main. The sprinkler grid is to provide a 10 by 10 foot (3.05 by 3.05 m) sprinkler spacing, and sprinkler deflectors are to be located 10 inches (254 mm) below the ceiling for pendent sprinklers and 7 inches (178 mm) below for upright sprinklers. See Figure 48.1.

48.4 Temperatures are to be recorded by means of 24 thermocouples located near the ceiling. Six thermocouples, identified as Nos. 1 – 6 in Figure 48.1, are to be located 2 inches (50.8 mm) below the ceiling and directly above the sprinklers, and eighteen thermocouples are to be located next to the heat sensitive element of each sprinkler.

48.5 The water supply for the sprinkler system is to be adjusted to provide an average waterflow of 0.15 gallons per minute per square foot of floor area (0.11 L/s/m^2) for 5.6 nominal “K” factor sprinklers when all sprinklers are operating.

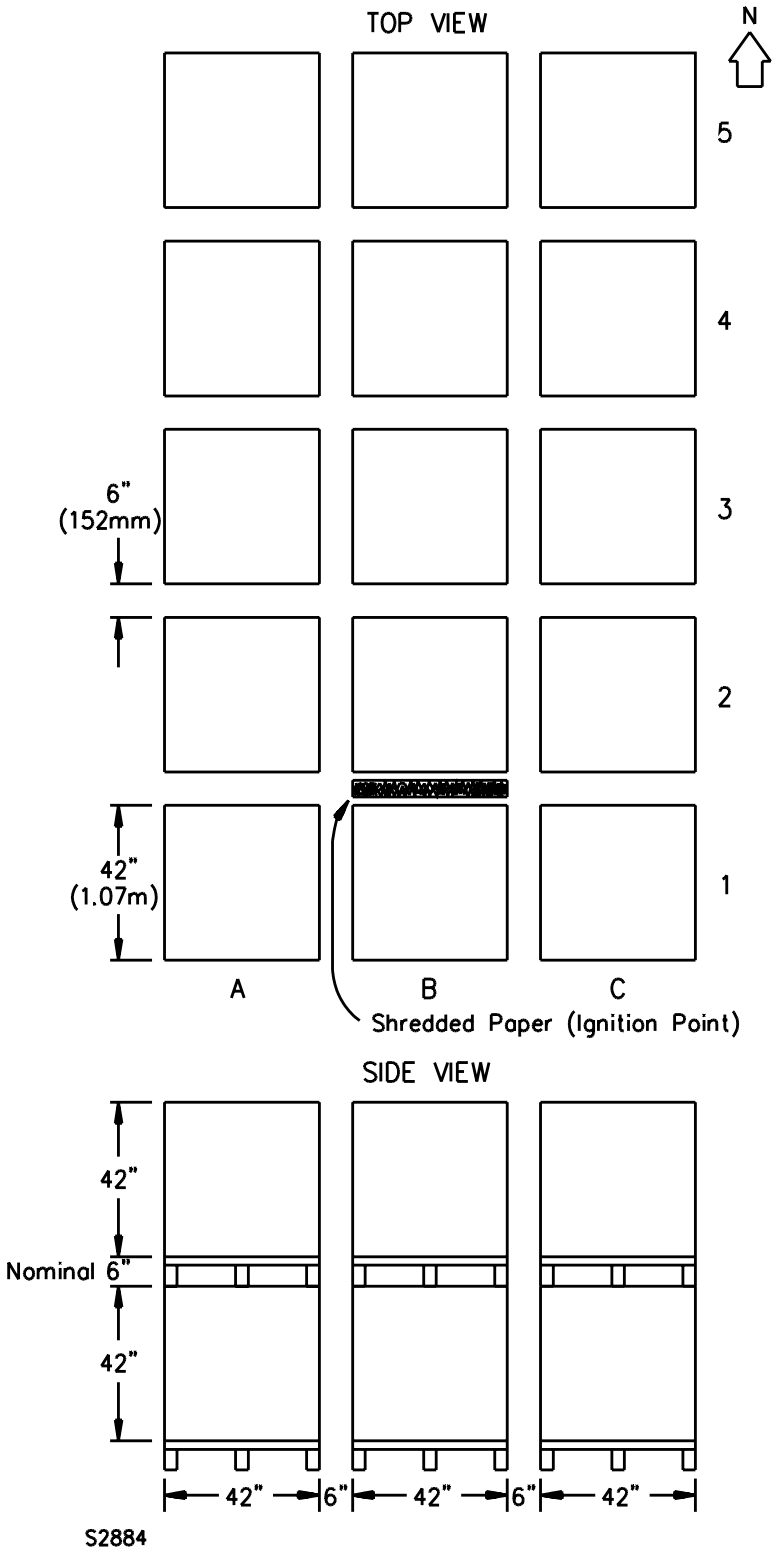
48.5 revised January 24, 2000

48.6 The waterflow during sprinkler discharge is to be continuously monitored so that the waterflow is capable of being adjusted as required during the test to provide the average sprinkler discharge flow rate specified in 48.5.

48.7 The piled stock is to consist of 30 tri-wall corrugated cartons (see 48.8) placed on pallets and arranged in a pile that is three pallet-cartons wide by five long by two high. See Figure 48.2. A 6-inch (152-mm) free space is to be maintained between all carton stacks.

Figure 48.2
Carton arrangement

Figure 48.2 revised May 25, 1999



48.8 Each carton is to measure 42 by 42 by 42 inches (1.1 by 1.1 by 1.1 m), and is to comply with the requirements for Class 2, Style E, ″AAA″ fluting, triple wall corrugated fiber boards as specified in the Federal Specification for Boxes, Fiberboard, Corrugated, Triple-Wall, PPP-B-640D (August 7, 1969). The distance from the inside of the inside wall to the outside of the outside wall is to be 1/2 inch (12.7 mm). Inside each carton is to be placed a carton complying with all of the above, except that each of these cartons is to measure 41 by 41 by 41 inches (1.0 by 1.0 by 1.0 m).

48.9 To provide structural stability during this test, two pieces of 56 by 40-inch wire fabric or 0.053 – 0.059 inch (1.35 – 1.50 mm) thick sheet metal are to be placed, in crisscross fashion, in each inside carton. Each support member is to be cut in its middle to facilitate insertion of the other diagonal member.

48.10 The ignition source for the fire test is to consist of 1.5 pounds (0.68 kg) of shredded paper placed on the floor in the space between the first and second carton in the middle row as illustrated in Figure 48.2 and ignited.

48.11 The fire test is to be continued until the fire is extinguished or until more than 50 percent of the piled stock is destroyed.

48.12 At the completion of water discharge, when the fire in the cartons has not been extinguished, it is to be carefully extinguished to prevent further destruction. The cartons are to be examined visually to determine compliance with the requirement specified in of 48.1(a). When it is not obvious that less than 50 percent of the cartons have been destroyed, the cartons are to be:

a) Oven dried and weighed so that the weight of the cartons is capable of being compared with the weight of unaltered cartons, or, when oven drying is not possible; then

b) Weighed 7 days after the fire test so that the weight of the cartons is capable of being compared with the weight of new cartons. During the 7 days, the cartons are to be stored in a sheltered area.

49 Piled Stock Fire Test for Extended Coverage Sprinklers Intended for Ordinary Hazard Occupancies

49.1 When tested as described in 49.2 – 49.11, the water discharge from the sprinkler shall:

a) Not result in operation of more than the maximum number of sprinklers specified in Table 49.1 within 45 minutes of the start of the test.

b) Result in the ceiling temperature to be reduced to a value less than 530°F (295°C) above ambient within 5 minutes after start of water discharge. Additionally, from the time the temperature initially falls below 530°F above ambient to the end of the test, the ceiling temperature shall not exceed this value for more than three consecutive minutes and the average temperature for this period shall not exceed 530°F above ambient.

49.1 effective October 8, 1998

49.2 The test room for the fire tests shall have provisions for venting the heat and smoke and for drainage of the sprinkler discharge. See Figure 49.1 for a typical test room.

49.2 effective October 8, 1998

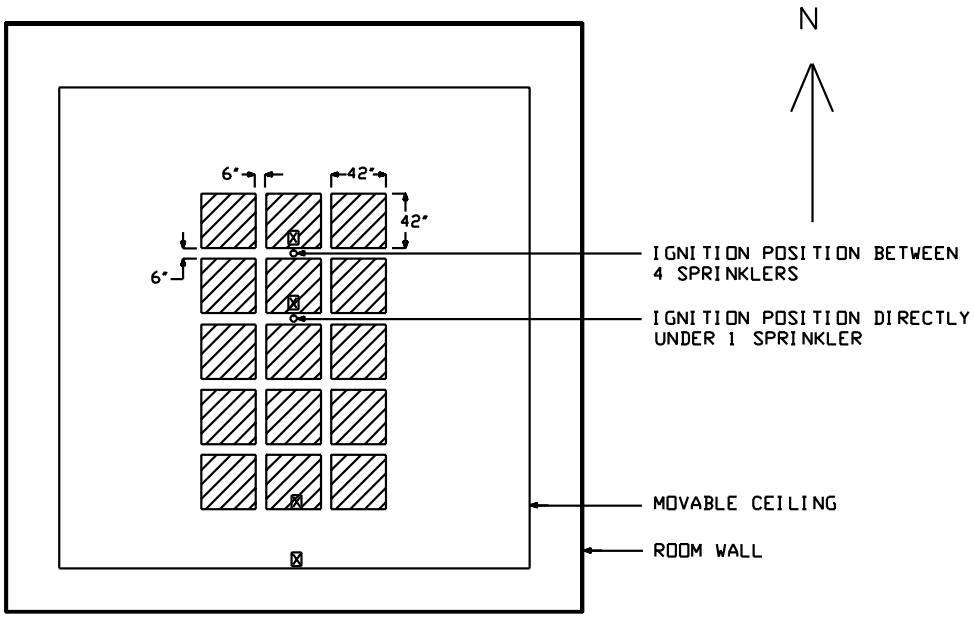
Table 49.1
Piled stock fire test conditions and criteria

Table 49.1 effective October 8, 1998

Sprinkler coverage area, feet	Test flow per sprinkler, gpm	Maximum number of sprinklers to operate
20 by 20	80	5
18 by 18	65	5
16 by 16	51	6
14 by 14	39	8

Figure 49.1
Location of piled cartons

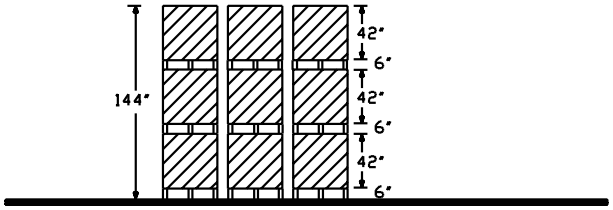
Figure 49.1 effective October 8, 1998



o - IGNITION SOURCE 1-1/2 LBS SHREDDED PAPER
⊠ - THERMOCOUPLE POSITIONED 2" BELOW CEILING ABOVE BOXES
NOTE - THERMOCOUPLES ALSO POSITIONED NEXT TO EACH SPRINKLER

PLAN VIEW

CARTON ARRANGEMENT



ELEVATION VIEW
(CARTONS ONLY)

▨ - 42" X 42" X 42" DOUBLE TRI-WALL METAL LINED CARTONS

SM1032B

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49.3 In the first fire test, the sprinklers are to be installed in the test room at the maximum sprinkler spacing specified by the manufacturer with the ignition source located between four automatic sprinklers arranged to discharge water as specified in Table 49.1. The sprinkler grid is to consist of three 1-1/2-inch branch lines that are looped on both ends. Each branch line is to be individually supplied from a minimum 2-1/2 inch cross main. The sprinkler deflectors are to be located 12 inches (304 mm) below the ceiling. A clearance of 18 inches (457 mm) between the sprinkler deflector and the commodity is to be provided.

49.3 effective October 8, 1998

49.4 In the second test, the sprinklers are to be installed in the test room, using the minimum spacing specified by the manufacturer, with the ignition source located directly below one sprinkler with each sprinkler flowing water corresponding to the values specified in Table 49.1 for the applicable coverage area. A clearance of 10 feet (3.05 m) between the sprinkler deflector and the top of commodity is to be provided.

49.4 effective October 8, 1998

49.5 Temperatures are to be recorded by means of thermocouples located near the ceiling, which are to be located 2 inches (50.8 mm) below the ceiling and directly above the boxes. Additional thermocouples are to be located next to the heat sensitive element of each sprinkler.

49.5 effective October 8, 1998

49.6 The waterflow during sprinkler discharge is to be continuously monitored so that the waterflow is to be adjusted as required during the test to provide the applicable sprinkler discharge flow specified in Table 49.1.

49.6 effective October 8, 1998

49.7 The piled stock is to consist of 45 tri-wall corrugated cartons (see 49.8) placed on pallets and arranged in a pile that is three pallet-cartons wide by five long by three high. See Figure 49.1. A 6-inch (152-mm) free space is to be maintained between all carton stacks.

49.7 effective October 8, 1998

49.8 Each carton having moisture content of 10 ±2 percent is to measure 42 by 42 by 42 inches (1.1 by 1.1 by 1.1 m), and is to comply with the requirements for Class 2, Style E, ″AAA″ fluting, triple wall corrugated fiber boards as specified in the Federal Specification for Boxes, Fiberboard, Corrugated, Triple-Wall, PPP-B-640D (August 7, 1969). The distance from the inside of the inside wall to the outside of the outside wall is to be 1/2 inch (12.7 mm). Inside each carton is to be placed a carton complying with all of the above, except that each of these cartons is to measure 41 by 41 by 41 inches (1.0 by 1.0 by 1.0 m).

49.8 effective October 8, 1998

49.9 To provide structural stability during these tests, a five sided steel stiffener of 56 by 40-inch or 0.053 – 0.059 inch (1.35 – 1.50 mm) thick sheet metal are to be placed, in each inside carton.

49.9 effective October 8, 1998

49.10 The ignition source for the first fire test is to consist of 1.5 pounds (0.68 kg) of shredded paper placed on the floor in the space between the first and second carton in the middle row as illustrated in Figure 49.1 and ignited.

49.10 effective October 8, 1998

49.11 The fire test is to be continued for 45 minutes.

49.11 effective October 8, 1998

50 Distribution Tests for Extended Coverage Sprinklers Intended for Ordinary Hazard Occupancies

50.1 The water collected in any individual collection pan, the average water collected for all collection pans in the distribution area, and the average water collected for collection pans in any 16 square feet (1.5 m^2) area shall comply with the values specified in Table 50.1 with four sprinklers discharging water at the flows and distances above the collection pans specified in Table 50.1. The sprinklers shall be tested using the coverage areas specified by the manufacturer.

50.1 effective October 8, 1998

Table 50.1
Pan collection values

Table 50.1 effective October 8, 1998

Sprinkler coverage area, ft by ft	Number of collection pans	Deflector to pan distance, ft	Waterflow per sprinkler, gpm	Minimum collection in any individual pan gpm/ft^2	Minimum average collection in any 16 ft^2 area, gpm/ft^2	Minimum average collection in all pans, gpm/ft^2
14 x 14	64	7.5	30	0.075	0.11	0.15
	64	7.5	39	0.10	0.15	0.20
	64	3.0	30	0.03	0.08	0.15
	64	3.0	39	0.03	0.11	0.20
16 x 16	100	7.5	39	0.075	0.11	0.15
	100	7.5	51	0.10	0.15	0.20
	100	3.0	39	0.03	0.08	0.15
	100	3.0	51	0.03	0.11	0.20
18 x 18	144	7.5	49	0.075	0.11	0.15
	144	7.5	65	0.10	0.15	0.20
	144	3.0	49	0.03	0.08	0.15
	144	3.0	65	0.03	0.11	0.20
20 x 20	196	7.5	60	0.075	0.11	0.15
	196	7.5	80	0.10	0.15	0.20
	196	3.0	60	0.03	0.08	0.15
	196	3.0	80	0.03	0.11	0.20

50.2 Four open sprinklers are to be installed in their intended position (upright or pendent) in the 1.5 by 1.5 by 3/4 inch (38.1 by 38.1 by 19.05 mm) tees, each supplied with water through two 1.5 inch (38.1 mm) diameter pipes with sprinklers placed at the corners of spacings specified by the manufacturer. The upright and pendent sprinkler deflectors are to be located 7 inches (0.178 m) below flat ceiling and frame arms are to be parallel to the piping on which it is installed. A ceiling mounted sprinkler type is to be installed as specified by the manufacturer.

50.2 effective October 8, 1998

50.3 Collection pans, having dimensions of 1 foot square (305 mm square), are to be centered below the sprinklers at distances below the sprinkler deflectors as specified in Table 50.1.

50.3 effective October 8, 1998

50.4 Water is to be discharged for 10 minutes. The amount collected in each pan is to be measured, and the density in gallons per minute per square foot (L/s per m^2) calculated.

50.4 effective October 8, 1998

51 High Temperature Exposure Test For Flow Control (FC) Sprinklers

51.1 After being conditioned as described in 51.2, the change in the average discharge coefficient ″K″ of an FC sprinkler shall not exceed 10 percent when compared with sprinklers that have not been conditioned.

51.2 Five sprinklers are to be conditioned for 1 hour in a preheated circulating air oven maintained at 1000°F (537°C). The sprinklers then are to be removed from the oven and allowed to cool for at least 3 hours at room temperature.

51.3 After cooling, the sprinklers are to be subjected to the Calibration Test, Section 29, to determine compliance with the requirements in 51.1.

51.4 The sprinklers are to be maintained in their intended installation position at all times during the exposure and while being subjected to the Calibration Test, Section 29.

MANUFACTURING AND PRODUCTION TESTS

52 General

52.1 The manufacturer shall provide regular production control, inspection, and tests. The program shall include at least the tests specified in Production Leakage Test, Section 53, and Frangible Bulb Integrity Test, Section 53A, for each sprinkler.

Revised 52.1 effective September 26, 2004

53 Production Leakage Test

53.1 Each automatic sprinkler shall not leak when subjected to the appropriate hydrostatic test pressure as specified in Table 53.1, maintained for not less than 2 seconds. See 53.2.

53.1 revised October 8, 1997

Table 53.1
Test pressures for the production leakage test

Table 53.1 added October 8, 1997

Rated pressure		Test pressure	
psig	(MPa)	psig	(MPa)
175	(1.2)	500	(3.4)
250	(1.7)	500	(3.4)
300	(2.1)	600	(4.1)

53.2 Other test arrangements shall be permitted to be utilized when determined to be equivalent.

53A Frangible Bulb Integrity Test

53A.1 After being subjected to the production leakage test, a frangible bulb sprinkler assembly shall be evaluated for integrity of the frangible bulb for cracking, breaking, or other damage as indicated by the loss of fluid. For example, the bubble in each frangible bulb shall be examined at room ambient temperature. The sprinkler shall then be heated in a circulating air oven or liquid bath to 5°C below the minimum operating temperature range of the sprinkler. The bubble shall then be examined to determine the bubble size has been reduced in accordance with the frangible bulb manufacturer's specifications. After cooling, the bubble size shall again be examined to determine the bubble returned to the original size within the tolerance allowed by the frangible bulb manufacturer.

Added 53A.1 effective September 26, 2004

MARKING

54 General

54.1 A four- to six-character identification number, with no intervening spaces, shall be used to identify the manufacturer and sprinkler operating characteristics. The number shall be cast or die-stamped on the sprinkler deflector or on a visible non-operating part, which is not used to install the sprinkler. In addition, the identification number for decorative ceiling sprinklers is permitted to be located behind the cover plate that is removable with common tools, provided the number will be visible after the sprinkler is installed and the cover plate is removed.

Revised 54.1 effective January 20, 2001

54.2 The identification number shall consist of one or two characters which identify the manufacturer, followed by three or four digits to identify a unique sprinkler identification for orifice size or shape, deflector characteristic, pressure rating and thermal sensitivity classification.

Revised 54.2 effective June 8, 2005

54.3 Deleted 54.3 effective January 20, 2001

54.4 Deleted 54.4 effective January 20, 2001

54.5 The deflector of sprinklers intended for horizontal sidewall installation shall be marked with the word TOP. See 54.7.

Revised 54.5 effective January 20, 2001

54.6 Deleted 54.6 effective January 20, 2001

54.7 The deflector of a sidewall sprinkler shall clearly show its intended orientation with regard to the direction of flow. When an arrow is used to indicate the direction of flow, it shall be accompanied by the word FLOW.

54.8 The year of manufacture shall be die-stamped or cast on a visible area of automatic sprinklers. Temperature ratings shall be die-stamped or cast on a visible area of the sprinklers. Sprinklers produced in the last 3 months of a calendar year shall be marked with the current year or the following year as the date of manufacture, and those produced in the first 6 months of a calendar year shall be marked with the preceding year or the current year as the date of manufacture. Other marking methods are capable of being used when determined to provide equivalent permanency to the method described above.

54.9 The frame arms of automatic sprinklers of the various temperature ratings shall be colored in accordance with the color code designated in Table 7.1.

Exception No. 1: The color identification for coated sprinklers shall be permitted to be a dot on the top of the deflector, the color of the coating material, or colored frame arms.

Exception No. 2: Frame arm color identification is not required for plated or painted sprinklers, ceiling sprinklers, or similar decorative types.

Exception No. 3: Frame arm or dot color identification is not required for sprinklers having frangible bulb heat responsive elements color coded in accordance with Table 7.1.

54.9 revised March 26, 2003

54.10 Plated, painted or coated decorative sprinklers shall be provided with a distinctive means to identify these finishes as being applied at the factory.

54.11 Deleted 54.11 effective January 20, 2001

54.12 When a manufacturer produces sprinklers at more than one factory, each sprinkler shall have a distinctive marking to identify it as the product of a particular factory.

54.12.1 When frangible bulb sprinklers are manufactured with more than one supplier of frangible bulbs, each sprinkler shall have a distinctive marking to identify the frangible bulb manufacturer.

54.12.1 revised March 26, 2003

54.13 Deleted 54.13 effective January 20, 2001

54.14 Deleted 54.14 effective January 20, 2001

54.15 Deleted 54.15 effective January 20, 2001

54.16 Deleted 54.16 effective January 20, 2001

54.17 An escutcheon intended for installation with recessed and concealed type sprinkler assemblies and not attached by the manufacturer shall be marked as follows: ″FOR USE WITH (SPRINKLER IDENTIFICATION NUMBER(S) AND SPRINKLER TEMPERATURE RATING(S)).″

54.17 revised December 8, 2003

54.18 The cover plate for a concealed sprinkler shall be marked with the words: ″Do not paint″ on the exterior surface.

54.19 Deleted effective June 6, 2005

54.20 Protective covers shall be orange in color and shall be marked to indicate that the cover must be removed before the sprinkler system is placed in service. The marking shall be placed on the cover so it is visible after sprinkler installation.

54.20 effective September 26, 2004 for sprinklers with a glass bulb having a diameter of greater than 4 mm

INSTALLATION INSTRUCTIONS

55 Design Parameters and Installation Instructions

55.1 Each package of extended coverage, dry type, quick response, sidewall type and flow control sprinklers; and sprinklers for installation not specifically outlined in the National Fire Protection Association Standard for Installation of Sprinkler Systems, NFPA 13-96, shall be provided with design parameter instructions or with a statement indicating that design parameter instructions are available from the manufacturer. The design parameter instructions for dry and extended coverage sprinklers shall include the minimum operating pressure. The design parameter instructions for an extended coverage sprinkler shall specify the coverage area dimensions, minimum waterflow rate, the orifice size, and the ″K″ factor, and the type of ceiling configuration under which the ceiling is to be installed.

55.1 effective June 17, 1997

55.2 Each box of ceiling type sprinklers shall be provided with installation instructions that specify the method of sprinkler assembly.

55.3 Installation instructions for dry sprinklers installed in dry systems shall include information on the appropriate sprinkler-fitting compatibility, so as to minimize the potential to accumulate water, scale, and sediment of the sprinkler inlet and provide for an unobstructed flow path upon operation.

55.3 effective October 8, 1998

55.4 Each box of sidewall and extended coverage (EC) sidewall sprinklers shall be provided with installation instructions that specify the ranges for deflector distances below the ceiling of 4 – 6, 6 – 12, 12 – 18, 4 – 12, 4 – 18, or 6 – 18 inches.

Added 55.4 effective October 8, 1998

APPENDIX A

A1 TOLERANCE LIMIT CALCULATION METHODS

A1.1 The calculation methods for determining compliance with the tolerance limit requirements specified in 13.2.1 and 19.3.1 are described in A1.2 – A1.5.

A1.2 Record the sample operation time in decimal form.

A1.3 Calculate the mean and unbiased standard deviation. The sample unbiased standard deviation (S) is calculated from the formula:

$$S = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \bar{X})^2}{n-1}}$$

in which:

$\bar{X}$ *= sample mean*

X_i *= individual values of each sample tested*

n = number of samples tested

A1.4 Determine K, where K is a factor specified in Table A1.1 (Table for K, Factors for One-Sided Tolerance Limits for Normal Distributions):

a) In calculations for the Strength of Heat Responsive Element Test for Frangible Bulb Types (13.2.1), use columns one and two of Table A1.1.

b) In calculations for the Response Test for Ceiling and Recessed Type Sprinklers – Ordinary and Intermediate Temperature Rated (19.3), use columns one and three of Table A1.1.

A1.4 revised July 9, 2001

A1.5 The steps to complete the comparison with the requirements specified in 13.2.1 are to be performed as indicated in Figure A1.1. The steps to complete the comparison with the requirements of 19.3.3 are to be performed as indicated in Figure A1.2.

Table A1.1
Table for K, factors for one-sided tolerance limits for normal distributions

n	Strength of heat responsive element test for frangible bulb types (13.2.1) γ = 0.99 p = 0.99 (99% of samples)	Response test for ordinary and intermediate temperature rated ceiling type sprinklers (including concealed, flush, and recessed) (19.3) γ = 0.95 p = 0.99 (99% of samples)
10	5.075	3.981
11	4.828	3.852
12	4.633	3.747
13	4.472	3.659
14	4.336	3.585
15	4.224	3.520
16	4.124	3.463
17	4.038	3.415
18	3.961	3.370
19	3.893	3.331
20	3.832	3.295
21	3.776	3.262
22	3.727	3.233
23	3.680	3.206
24	3.638	3.181
25	3.601	3.158
30	3.446	3.064
35	3.334	2.994
40	3.250	2.941
45	3.181	2.897
50	3.124	2.863

Figure A1.1
Tolerance limit worksheet for strength of heat responsive element test for frangible bulb types (13.2.1)

Sample Bulb Strength Values, Pounds (Kg)	Sprinkler Assembly Load Values, Pounds (Kg)

$\bar{X}_1$ [Mean Bulb Strength, Pounds (Kg)]

S_1 [Sample Unbiased Standard Deviation for $\bar{X}_1$ Pounds (Kg)]

$\bar{X}_2$ [Mean Assembly Load, Pounds (Kg)]

S_2 (Sample Unbiased Standard Deviation for $\bar{X}_2$)

K_1 (Bulb Strength Factor from Table A1.1 for $\gamma = 0.99$ and $P = 0.99$)

K_2 (Assembly Load Factor from Table A1.1 for $\gamma = 0.99$ and $P = 0.99$)

TL_2 (Upper Tolerance Limit for Sprinkler Assembly Load = $\bar{X}_2 + K_2S_2$)

TL_1 (Lower Tolerance Limit for Bulb Strength = $\bar{X}_1 - K_1S_1$)

Sample Data Is Capable Of Being Used When $TL_1 > 2TL_2$

Figure A1.2
Tolerance limit worksheet for response test for ordinary and intermediate temperature rate ceiling type sprinklers (including concealed, flush, and recessed) (19.3) Operation Times

Min:Sec = Min (Decimal)		Min:Sec = Min (Decimal	
$\bar{X}$ (Mean Sample Sprinkler Operating Time, Minutes)	=		
S (Sample Unbiased Standard Deviation, Min)	=		
n (Sample Size)	=		
K (Factor from Table A1.1 for $\gamma = 0.95$ and $P = 0.99$	=		
TL (Tolerance Limit = $\bar{X}$ + KS)	=		

Sample Data Is Capable Of Being Used When:

TL ≤ 3.15 For Intermediate Temperature Rated Ceiling Type Sprinklers

Superseded requirements for
the Standard for
Automatic Sprinklers for Fire-Protection Service

UL 199, Tenth Edition

The requirements shown are the current requirements that have been superseded by requirements in this edition. The numbers in parentheses refer to the new requirements with future effective dates that have superseded these requirements. To retain the current requirements, do not discard the following requirements until the future effective dates are reached.

19.2.1 A QR sprinkler shall have the following operating time characteristics when tested in the sensitivity test oven as specified in 19.2.3 – 19.2.5:

a) Fourteen seconds or less for each sprinkler when subjected to the test in 19.2.3.

b) Mean time equal to or less than a 1.30 multiple of the mean time of the sprinkler tested in accordance with (a) after being subjected to the exposure tests specified in Sections 23, 26, 28, and 35.

19.2.2 A standard response sprinkler shall have an operating time greater than 14 seconds and not greater than the maximum operating time specified in Table 19.1 when tested in the oven heat test as specified in 19.2.3 – 19.2.5.

Exception: The 14 second minimum time of the oven sensitivity test does not apply to extended coverage and ceiling type sprinklers complying with the Room Heat Test for QR and QR Extended Coverage Sprinklers in 19.5.1 – 19.5.5.

Table 19.1
Maximum operating time for sprinklers in sensitivity oven

Sprinkler temperature rating, degrees		Oven temperature, degrees		Maximum operating time, seconds, for sprinkler types			
F	(C)	F ±2°F	(C ±1°C)	Quick response type	Standard response type	Ceiling[a] type	Coated type[b]
135 – 170	(57 – 77)	275	(135)	14	100	100	180
175 – 225	(79 – 107)	386	(197)	14	100	100	180
250 – 300	(121 – 149)	555	(290)	14	100	–	180
325 – 375	(163 – 191)	765	(407)	–	100	–	180
400 – 475	(204 – 246)	765	(407)	–	120	–	180
500 – 575	(260 – 302)	765	(407)	–	180	–	180

[a] Ceiling sprinklers include recessed, flush, and concealed types.

[b] Corrosion resistant sprinklers with coated heat responsive elements including wax, lead, teflon, wax over lead, and polyester coatings.

19.2.4 The samples are to be conditioned at 75 ±2°F (24 ±1°C) for at least 2 hours. The inlet end of each sprinkler sample is to be connected to a source of air pressure at 4 ±1 psig (28 ±7 kPa) and quickly plunged into the sensitivity test oven in a pendent position. Each sprinkler is to be observed to determine if operation occurs as intended within the time specified in 19.2.1.

19.2.5 The sensitivity test oven is to consist of an 8 inch (203 mm) square stainless steel chamber as shown in Figure 19.1. A constant air velocity of 8.33 ±0.05 feet per second (2.54 ±0.01 m/s) and an air temperature as specified in Table 19.1 for each temperature rating and style sprinkler are to be established. Air velocity is to be measured using an orifice plate and a manometer or a bidirectional probe and a velometer. The air temperature is to be measured by use of a No. 30 AWG (0.05 mm^2) thermocouple centered upstream from the sprinkler as shown in Figure 19.1.

20.1 An automatic sprinkler of other than the upright dry-type shall operate at service pressures of 7 psig (48 kPa) to the rated pressure. All operating parts shall release with sharp, positive action. Operating parts intended to be released from the sprinkler assembly shall be thrown clear of the sprinkler frame and deflector so as not to impair the water distribution pattern.

20.2 An upright dry-type sprinkler of the maximum length shall operate at a pressure of 12.5 psig (86 kPa) or less, to clear from the waterway of all internal parts which adversely affects normal flow. When the minimum pressure required to clear operating parts exceeds 5 psig (34 kPa), the minimum operating pressure of such a sprinkler shall be designated as two times the minimum pressure required to clear operating parts.

20.3 For sprinklers rated 175 psig (1.2 MPa), 30 samples of automatic sprinklers are to be individually tested. Each sample is to be installed in its intended installation position on a rigid piping arrangement and supplied with flowing water at service pressures in accordance with the following: five sprinklers at 7 psig (48 kPa) [when the sprinkler is a dry upright type, 12.5 psig is to be used], five sprinklers at 25 psig (172 kPa), five sprinklers at 50 psig (345 kPa), five sprinklers at 75 psig (517 kPa), five sprinklers at 125 psig (862 kPa), and five sprinklers at 175 psig (1.21 MPa). In addition, for sprinklers having ratings exceeding 175 psig (1.2 MPa), five sprinklers shall be tested at each 25 psig (172 kPa) increment from 200 psig (1.38 MPa) to the rated pressure. Each sample is then to be operated by exposing the heat responsive element to a uniform application of heat. A sprinkler does not comply when a part interfering with correct water distribution maintains interference for a minimum of 1 minute under flowing water service pressure. The service pressure and the action of the operating parts, when releasing, are to be observed to determine compliance with these requirements.

20.4 Five samples of upright dry-type sprinklers of maximum length are to be individually tested. Samples are to be installed on piping connected to a water supply intended for the purpose. With the supply pressure at 0 psig (0 kPa), the heat responsive element of each sample is to be operated. The service pressure is then to be increased at a rate not greater than 1 psig (7 kPa) in 15 seconds. The pressure at which internal parts clear the waterway is to be noted.

52.1 The manufacturer shall provide regular production control, inspection, and tests. The program shall include at least the tests specified in Production Leakage Test, Section 53, for each sprinkler.

54.2 The identification number shall consist of one or two characters which identify the manufacturer, followed by three or four digits. The last digits shall be unique to each combination of model, orifice size, thermal sensitivity classification, and deflector or water discharge characteristics.

54.19 Sprinklers with rated pressures exceeding 175 psig (1.2 MPa) shall have the rated pressure marked, die-stamped, or cast on a visible area on a non-operating part of the sprinkler.