

NO. OF PAGES

27

17

41



Underwriters Laboratories Inc.®

A not-for-profit organization dedicated to public safety
and committed to quality service

April 12, 1996

Revision pages for

Standard for

Early-Suppression Fast-Response Sprinklers

UL 1767, Second Edition

Attached to this transmittal notice is a revision of the Second edition of UL 1767.

A CHANGE ON A PAGE DATED APRIL 12, 1996 IS INDICATED BY A SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEM, PRECEDED AND FOLLOWED BY AN ASTERISK.

THESE NEW AND REVISED REQUIREMENTS ARE NOW IN EFFECT.

The new and revised requirements are substantially in accordance with UL's bulletin on this subject dated December 1, 1995. The bulletin is now obsolete and may be discarded.

Revised and/or additional pages may be issued from time to time.

With the inclusion of the accompanying material, the standard consists of pages dated as shown in the following checklist:

Page	Date
1	January 27, 1995 (Reprinted April 12, 1996)
2, 3	April 12, 1996
4, 5	January 27, 1995
6	April 12, 1996
7	January 27, 1995
8	April 12, 1996
9 – 17	January 27, 1995
18 – 25	April 12, 1996
26, 27	January 27, 1995
28, 28A	April 12, 1996
29, 30	January 27, 1995
31 – 35	April 12, 1996
A1, B1 – B3	January 27, 1995

JANUARY 27, 1995

(Title Page Reprinted: April 12, 1996)

1

UL 1767

Standard for

Early-Suppression Fast-Response Sprinklers

First Edition – February, 1990

Second Edition

January 27, 1995

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 published set of revision pages.

ISBN 1-55989-705-8

COPYRIGHT © 1990, 1996 UNDERWRITERS LABORATORIES INC.

CONTENTS**FOREWORD****INTRODUCTION**

1 Scope	5
2 General	5
3 Glossary	5

CONSTRUCTION

4 General	7
5 Inlet Threads	7
6 Temperature Ratings, Classifications, and Color Codings	7
7 Nominal Orifice Sizes	7
8 Coatings and Platings	8

PERFORMANCE

9 General	8
10 Samples	8
11 Load on Heat Responsive Element Test	8
12 Strength of Heat Responsive Element Test	9
13 Leakage Test	10
14 Hydrostatic Strength Test	10
15 30-Day Leakage Test	10
16 Water Hammer Test	11
17 Operating Temperature (Bath) Test	11
18 Sensitivity Test	12
19 Operation – Lodgement Test	14
20 Flow Endurance Test	14
21 Operation – Cold Soldering Test	14
22 High Temperature Test	15
23 Strength of Frame Test	15
24 Impact Resistance Test	16
25 Vibration Test	16
26 Calibration Test	18
27 Actual Delivered Density (ADD) Test	18
28 10-Day Corrosion Test	26
29 30-Day Corrosion Test	27
30 90-Day Moist Air Test	27
31 Stress-Corrosion Cracking of Brass Sprinkler Parts Test	27
32 Stress-Corrosion Cracking of Stainless Steel Parts Test	28
33 Operational Tests on Sprinklers Incorporating Gaskets or "O" Ring Seals	28A
34 Elastomeric Parts Test	29
35 Rough Usage Test	29
36 Thermal Shock Test	30
37 Vacuum Test	30
38 Freezing Test	30

39 Evaporation Test for Sprinkler Coatings	30
39A Distribution Tests For ESFR Sprinklers For Use In Buildings Up To 40 feet (12.2 m) In Height	31
39B Thrust Force Test for ESFR Sprinklers for Use in Buildings Up to 40 feet (12.2 m) in Height	33

MANUFACTURING AND PRODUCTION TESTS

40 General	34
41 Production Leakage Test	34

MARKING

42 General	34
------------------	----

APPENDIX A

Standards for Components	A1
--------------------------------	----

APPENDIX B – TOLERANCE LIMIT CALCULATION METHODS

B1 General	B1
------------------	----

FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

1.1 These requirements cover early suppression fast response (ESFR) sprinklers intended for installation as part of sprinkler systems for fire-protection service. Requirements for installation and use of ESFR sprinklers are included in the Standard for the Installation of Sprinkler Systems, NFPA 13, as well as various other NFPA standards such as the Standard for General Storage, NFPA 231, and the Standard for Rack Storage of Materials, NFPA 231C.

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 involve a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the acceptable 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 cannot be judged to comply with this Standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this Standard.

2 General

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

2.2 A component need not comply with a specific requirement that:

- a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard; or
- b) Is superseded by a requirement in this standard.

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

2.4 Specific components are recognized as being 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 for which they have been recognized.

2.5 ESFR sprinklers are categorized by operating temperature rating, response time index (RTI), orifice size ("K" factor), installation position, type of coating or plating and other factors that influence use.

2.6 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

3 Glossary

3.1 For the purpose of these requirements, the following definitions apply.

3.2 **ACTUAL DELIVERED DENSITY (ADD)** – The rate of water discharge from a sprinkler onto the top of the protected horizontal surface under a fire condition.

3.3 **ASSEMBLY LOAD** – The extension force applied to the sprinkler frame by the assembly of its operating mechanism.

3.4 **Deleted April 12, 1996**

3.5 **DELIVERED DENSITY** – The rate of water discharge from a sprinkler onto the top of a protected horizontal surface under a nonfire condition.

3.6 **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 (MPa x 145).

3.7 **EARLY SUPPRESSION** – A characteristic of sprinkler performance whereby the first few operating sprinklers are able to provide an actual delivered density (ADD) to a fire in its early stage that is equal to or greater than the required delivered density (RDD).

3.8 **EARLY-SUPPRESSION FAST-RESPONSE (ESFR) SPRINKLER** – A quick acting sprinkler that automatically actuates and discharges water over a specified area to provide early suppression of a fire.

3.9 **HEAT RESPONSIVE ELEMENT** – That portion of a sprinkler that breaks, melts, or otherwise functions to initiate the automatic operation of the sprinkler when sufficient heat has been absorbed.

3.10 **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.

3.11 **ORIFICE** – The opening, usually circular, that controls the amount of water discharged from a sprinkler at a given pressure.

3.12 **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.

3.13 **REQUIRED DELIVERED DENSITY (RDD)** – The minimum rate of water that must be discharged from a sprinkler onto the top of a protected horizontal surface under a fire condition to achieve early suppression.

3.14 **RESPONSE TIME INDEX (RTI)** – A measure of the sensitivity of the sprinkler's heat responsive element.

3.15 **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.

CONSTRUCTION

4 General

4.1 An ESFR sprinkler shall be constructed to remain closed for extended periods of time without leakage and to operate as intended and release all operating parts at pressures of 5 – 175 psig (0.034 – 1.21 MPa).

4.2 An ESFR sprinkler shall be constructed and assembled so that, upon actuation, it releases parts that will clear the waterway and provide the intended discharge pattern.

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

4.4 An ESFR sprinkler shall be constructed so that visible, permanent damage will result from field adjustment or replacement of operating parts.

4.5 An ESFR sprinkler shall be constructed for installation using a standard wrench or a wrench that is made available to the installer.

5 Inlet Threads

5.1 The inlet end of an ESFR sprinkler, if threaded, shall be provided with 3/4-inch or larger NPT pipe threads. Inlet pipe threads shall comply with the Standard for Pipe Threads, General Purpose (Inch), ANSI/ASME B1.20.1-1983.

Exception: Sprinklers intended for use in installations where sprinkler fittings incorporate pipe threads other than NPT-type shall be provided with threads complying with a national pipe thread standard compatible with those fittings.

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

6 Temperature Ratings, Classifications, and Color Codings

6.1 The temperature ratings, classifications, and color coding of the frame arms or glass bulb heat responsive elements of an ESFR sprinkler shall be as specified in Table 6.1.

Table 6.1
Temperature ratings, classifications and color coding

Temperature rating °F (°C)	Temperature classification	Color code, frame	Color code, bulb
155 – 165 (68 – 74)	Ordinary	Uncolored or Black	Orange or Red
175 – 220 (79 – 104)	Intermediate	White	Yellow or Green

7 Nominal Orifice Sizes

7.1 An ESFR sprinkler shall have an orifice as specified in Table 7.1. The nominal orifice size is to be determined from the discharge coefficient "K", as specified by the Calibration Test, Section 26.

Table 7.1
Nominal orifice size

Nominal orifice size, inch	Nominal discharge coefficient "K"	Discharge coefficient "K" range
3/4	14.0	13.5 – 14.5
5/8	11.0	11.0 – 11.5

Table 7.1 revised April 12, 1996

7.2 An ESFR sprinkler shall have a mean "K" factor that is within the discharge coefficient range specified in Table 7.1, as determined by the Calibration Test, Section 26.

7.3 The diameter of a discharge orifice or any internal passage of an ESFR sprinkler shall be at least 0.37 inch (9.5 mm).

7.4 An ESFR sprinkler shall be provided with a pintle (a stationary pin or rod) 3/8 – 3/4 inch (9.5 – 19.1 mm) long having a diameter of 1/8 – 1/4 inch (3.2 – 6.4 mm) for identification purposes. See 42.6.

8 Coatings and Platings

8.1 The operation and distribution characteristics of an ESFR sprinkler shall not be impaired by the application of a factory-applied coating or plating when the sprinkler is tested in accordance with these requirements.

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

8.3 A coating shall not be brittle when new nor become brittle with age as specified by the Evaporation Test for Sprinkler Coatings, Section 39.

8.4 A coating shall not crack, flake, slip, or flow when tested in accordance with these requirements at the maximum permitted installation temperature as specified by the High Temperature Test, Section 22.

PERFORMANCE

9 General

9.1 To determine compliance with these requirements, the various types and patterns of an ESFR sprinkler shall be subjected to the performance tests described in Sections 11 – 39.

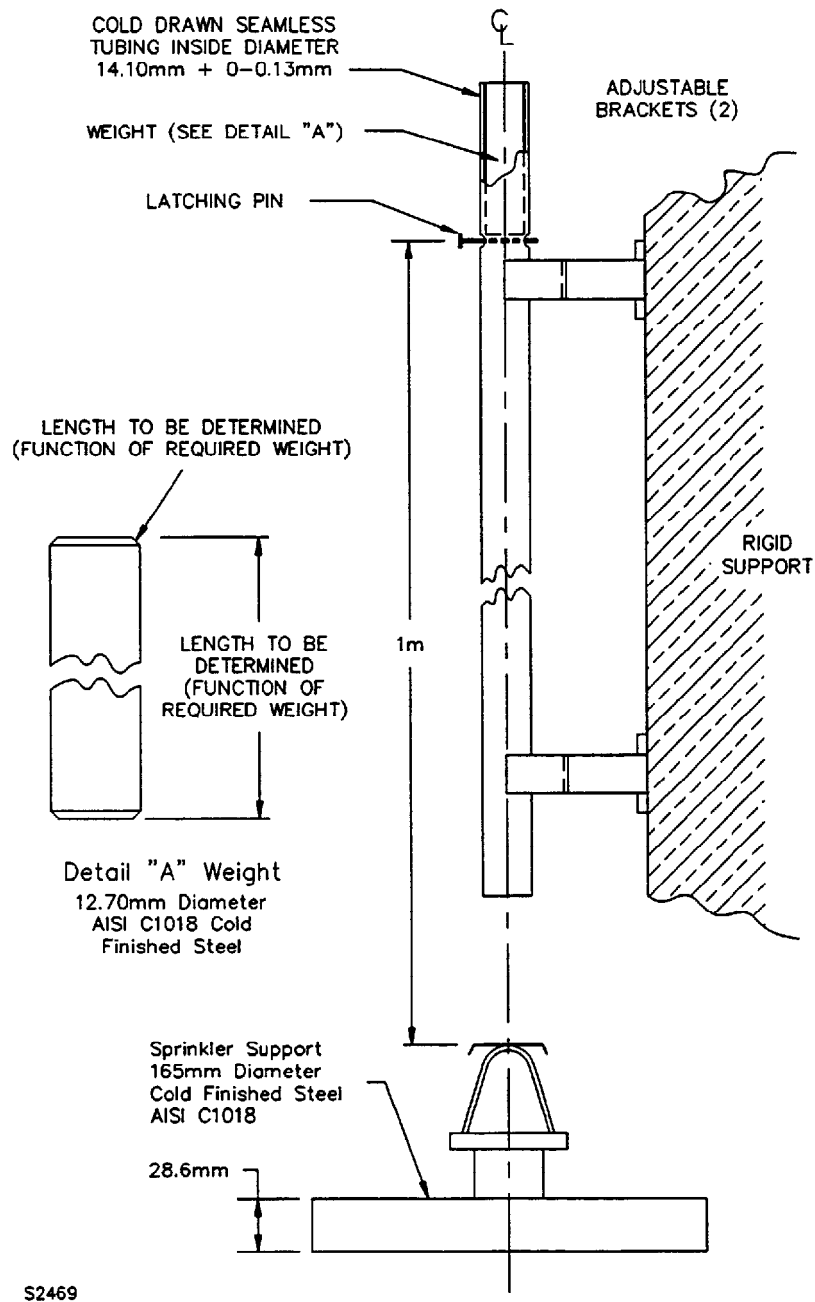
10 Samples

10.1 The number of samples required for investigation may vary for different types and patterns of an ESFR sprinkler and is to be determined following a review of detailed drawings, examination of a preliminary sample, or both.

11 Load on Heat Responsive Element Test

11.1 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. If 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 the Strength of Heat Responsive Element Test, Section 12.

Figure 24.1
Impact test apparatus



26 Calibration Test

26.1 The mean discharge coefficient "K" of an ESFR sprinkler shall be determined and shall comply with the values specified in Table 7.1.

26.2 Four sample sprinklers are to be individually installed on an outlet from a reservoir of sufficient size so that the velocity head effect ($V^2/2g$) is essentially reduced to zero.

26.3 Each sample is to be flow-tested first at a pressure of 15 psig (98 kPa) and then in 5-psig (34-kPa) increments up to 50 psig (345 kPa), 10 psig (68 kPa) increments up to 100 psig (689 kPa), and at 125, 150, and 175 psig (862, 1034, and 1210 kPa) and at the maximum design pressure, if higher than 175 psig. The pressure is then to be decreased in the same increments to 15 psig. 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 reading is to be made after equilibrium is attained. The discharge coefficient "K" is to be calculated by dividing the flow in gallons per minute ($L/S \times 15.85$) by the square root of the pressure in pounds per square inch (MPa $\times 145$). The mean "K" factor shall comply with the requirements specified in Table 7.1.

27 Actual Delivered Density (ADD) Test

27.1 When tested as described in 27.2 – 27.7, an open ESFR sprinkler shall have a minimum 16-pan and minimum flue space (4-pan) average of not less than those values specified in Table 27.1. In addition, the sum of the minimum 16-pan average and minimum flue space pan average values for the ten ADD tests shall not be less than the minimum sum values specified in notes a through d of Table 27.1.

Exception: An ESFR sprinkler is able to have ADD characteristics different from those specified in Table 27.1, when fire suppression can be demonstrated during full scale fire tests representing the installation conditions, protected storage configurations, and protected commodity specified for the sprinkler.

27.1 revised April 12, 1996

27.2 The test arrangement is to be as shown in Figures 27.1 – 27.6. The test parameters for each test are to be as specified in Table 27.1.

27.2 revised April 12, 1996

27.3 The enclosure for the tests is to be at least 30 by 30 by 28 feet (9.1 by 9.1 by 8.5 m) high. A smooth, flat horizontal ceiling at least 20 by 20 feet (6.1 by 6.1 m) in area is to be positioned in the center of the test enclosure. See Figure 27.2 for ceiling height.

27.3 revised April 12, 1996

27.4 Open ESFR sprinklers are to be installed on 2 inch (51 mm) diameter or larger piping with pendent style sprinkler deflectors positioned 13 ± 1 inches (330 ± 25 mm) below the ceiling and upright style sprinklers positioned 6 ± 1 inches (155 ± 25 mm) below the ceiling and at the minimum distance above the pipe specified by the manufacturer. Figures 27.3 – 27.6 show sprinkler locations for each test. The piping grid is to be connected to a water supply system. Each test is to be conducted three times with different sprinkler samples used for each test.

27.4 revised April 12, 1996

Table 27.1
Actual delivered density (ADD) measurement

Test number	Number of sprinklers centered over the ADD apparatus	Sprinkler spacing (ft)	Pipe spacing (ft)	Deflector to water collector clearance	Freeburn convective heat release (kBtu/min)	Pressure (psi)	Direction of feed flow	Minimum 16-pan average ADD, pans 1 – 16 (gpm/ft ²)		Minimum flue space (4 pan) average, pans 17 – 20 (gpm/ft ²)	
								K=14 ^a	K=11 ^b	K=14 ^c	K=11 ^d
1	1	0	0	15	75	50	Double	0.28	0.09	1.0	0.45
2	1	0	0	15	150	50	Double	0.28	0.06	1.0	0.20
3	2	12	0	3	150	50	Double	0.25	0.16	N/R	
4	2	12	0	3	150	150	Double	0.35	0.44	N/R	
5	2	12	0	15	150	50	Double	0.20	0.12	N/R	
6	2	0	12	3	150	50	Double	0.25	0.16	N/R	
7	2	0	12	3	150	150	Double	0.40	0.18	N/R	
8	2	0	12	15	150	50	Double	0.20	0.30	N/R	
9	4	8	12	3	150	50	Double	0.50	0.29	N/R	
10	4	8	12	3	150	150	Double	0.60	0.32	N/R	

^a K=14 Sum of minimum 16-Pan Average ADD = 3.8 gpm/ft².

^b K=11 Sum of minimum 16-Pan Average ADD = 2.1 gpm/ft².

^c K=14 Sum of minimum Flue Space (4-Pan) Average = 4.6 gpm/ft².

^d K=11 Sum of minimum Flue Space (4-Pan) Average 2.6 gpm/ft².

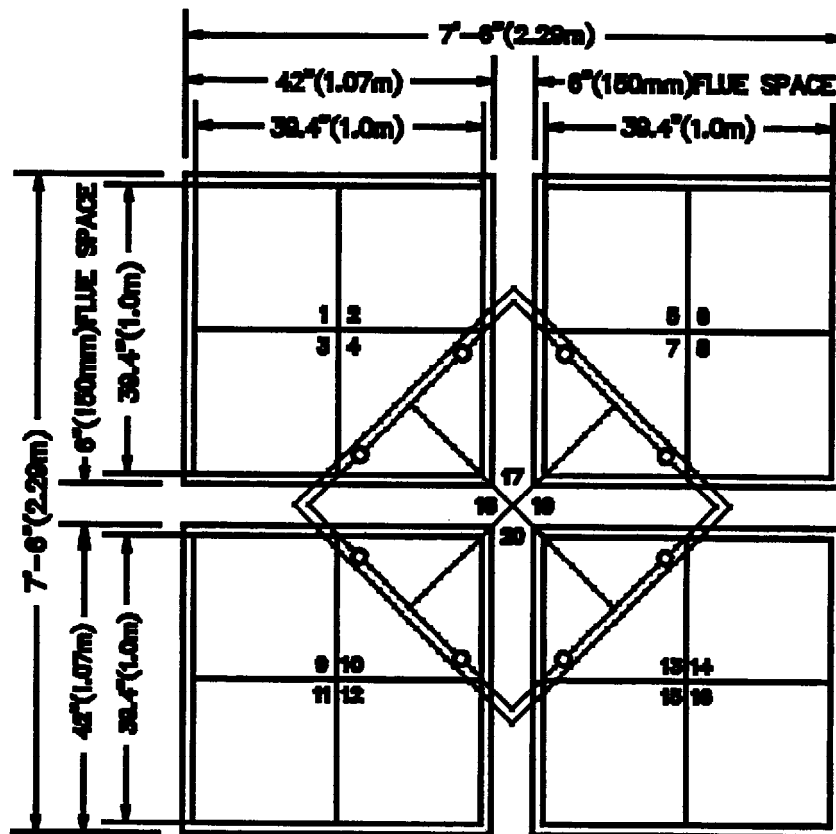
NR - No minimum required.

Table 27.1 revised April 12, 1996

Table 27.2
Minimum sum of characteristic ADD and
sum of average collected densities

Table 27.2 deleted April 12, 1996

Figure 27.1
ADD test arrangement — plan view



○ — HEPTANE NOZZLE CLUSTER LOCATION

S3461

Note: Each number 1 – 20 represents a collection pan; collection pans 17 – 20 collect flue water and are to be located below collection pans 1 – 16 (see 27.2).

Figure 27.1 revised April 12, 1996

Figure 27.2
ADD test arrangement – elevation view

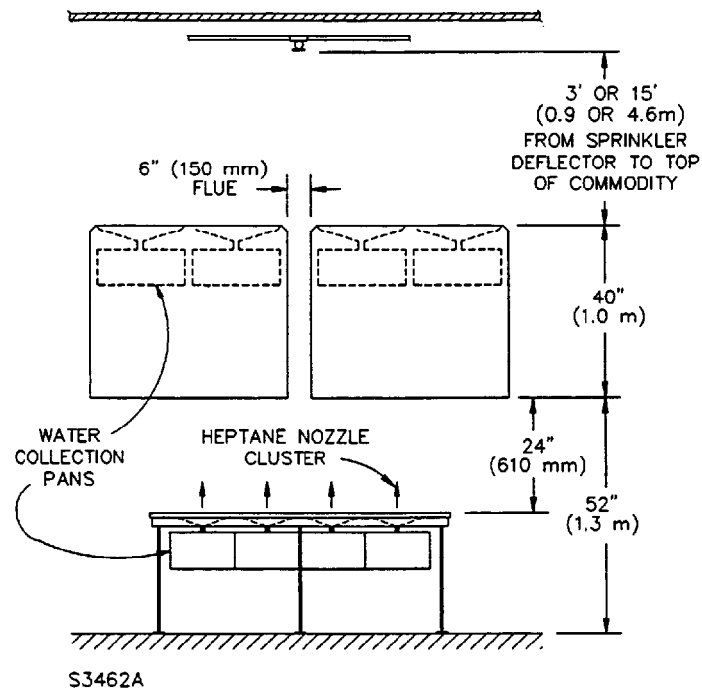


Figure 27.2 revised April 12, 1996

Figure 27.3
ADD tests 1 and 2, one sprinkler

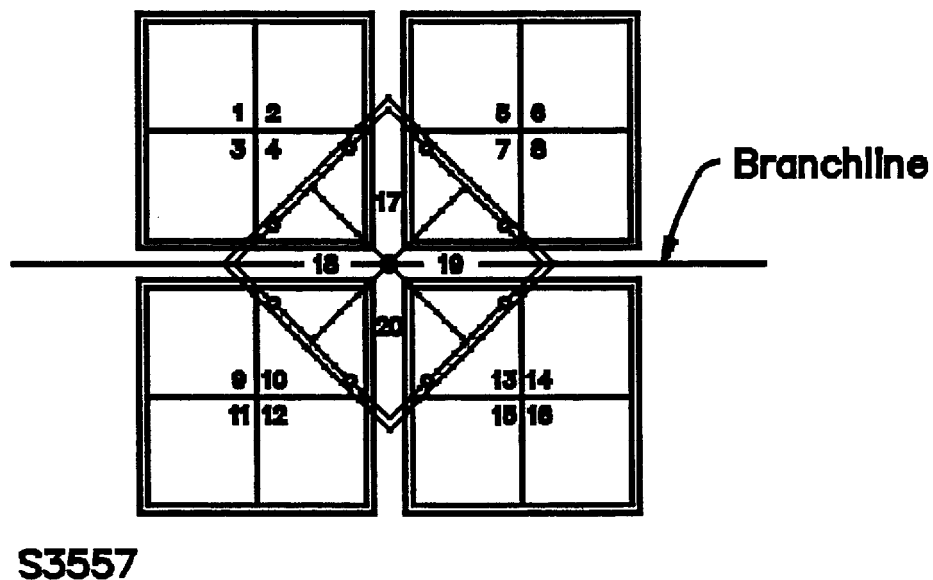
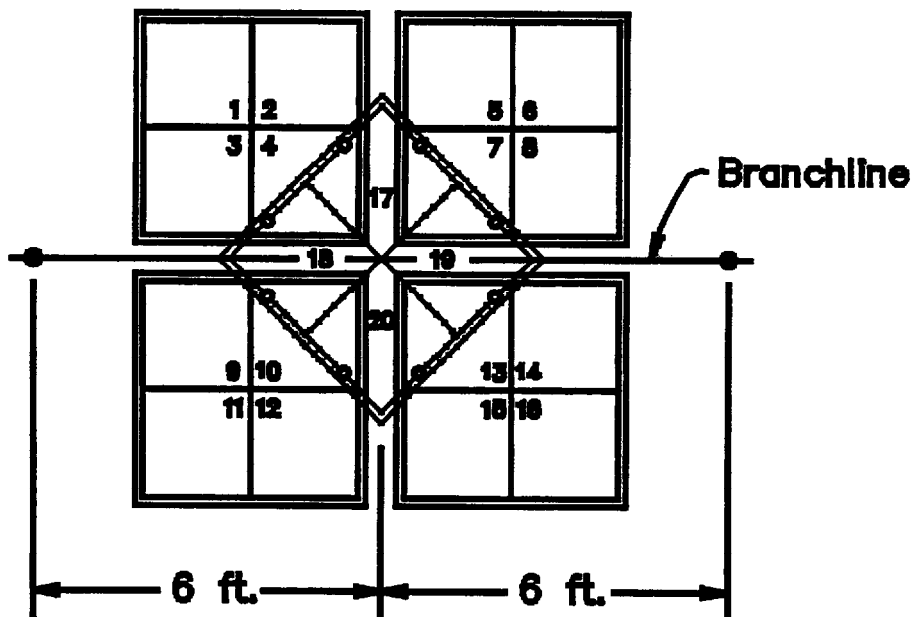


Figure 27.3 revised April 12, 1996

Figure 27.4
ADD tests 3 – 5, two sprinklers

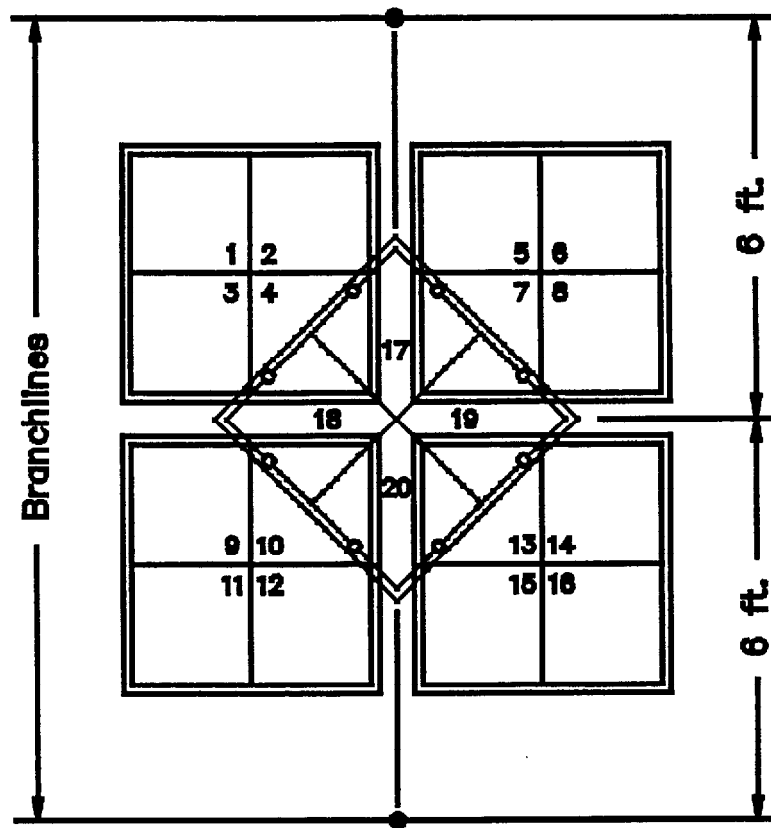


S3558

Note: 1 foot = 0.304 m

Figure 27.4 revised April 12, 1996

Figure 27.5
ADD tests 6 – 8, two sprinklers

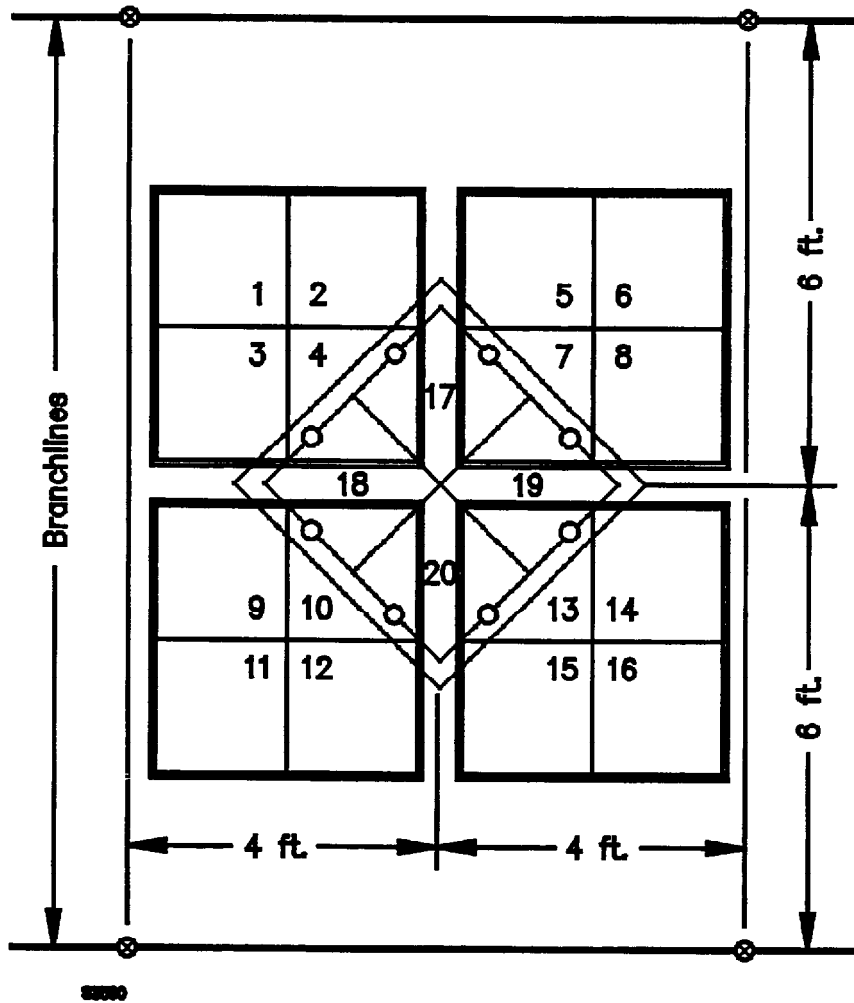


S3559

Note: 1 foot = 0.304 m

Figure 27.5 revised April 12, 1996

Figure 27.6
ADD tests 9 – 10, four sprinklers



Note: 1 foot = 0.304 m

Figure 27.6 revised April 12, 1996

Figure 27.7
ADD tests 25 – 30, four sprinklers

Figure 27.7 deleted April 12, 1996

Figure 27.8
ADD tests 31 – 36, four sprinklers

Figure 27.8 deleted April 12, 1996

27.5 Twenty automatic water collection pans are to be positioned as shown in Figure 27.1. Each water collection pan is to be 19.7 inches (0.5 m) square. Water collection pans 1 – 16 are to be located in four groups of four pans. Each group of four pans is to be placed inside of a 42 by 42 by 40 inch high (1.07 by 1.07 by 1.02 m high) container. The remaining four water collection pans 17 – 20 are to be positioned 24 inches (610 mm) below the bottom of the four containers and rotated 45 degrees. These water collection pans are used to measure the amount of water discharged into them via the 6-inch (150-mm) flue space between each group of four pans. Each water collection pan is to be fitted with a 19.7 by 19.7 inches (500 by 500 mm) lid. The lid is to be constructed so that the sprinkler discharge is directed into the automatic water collection pan.

27.6 To provide the specified rate of heat release for each test, a manifold of 24 heptane nozzles, in eight clusters of three, is to be located along the perimeter of flue collection pans 17 – 20, as shown in Figure 27.1. The heptane nozzle clusters are to be positioned at the midpoint of each water collection pan. Each heptane nozzle is to have an integral strainer, a rated flow of 5 gallons per hour (18.9 l/h) and a 70 degree hollow cone discharge pattern.

27.7 For each test, the ceiling is to be positioned to provide the specified deflector to water collection pan clearance of 3 or 15 feet (0.9 or 4.6 m), as required by Table 27.1. The water and heptane flow rates are to be adjusted to their specified test values and the amount of water being discharged into the water collection pans 1 – 16 and 17 – 20 is to be recorded for 5 minutes.

27.8 **Deleted April 12, 1996**

28 10-Day Corrosion Test

28.1 The external parts of an ESFR sprinkler that does not have a corrosion-resistant coating or plating shall withstand an exposure to salt spray; hydrogen sulfide; and carbon dioxide-sulfur dioxide atmospheres when tested in separate groups of samples in accordance with 28.3 – 28.8 for a period of 10 days each. Following the exposure, each sample shall comply with the Sensitivity Test, Section 18.

28.2 During the corrosive exposure, the sprinkler inlet is to be sealed by a plastic cap after the sprinkler has been filled with deionized water and provisions taken to prevent condensation from falling directly onto the test samples.

28.3 Each sample is to be subjected to the Sensitivity Test, Section 18, within 1 to 5 days following the exposure period.

28.4 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.

28.5 The samples are to be supported vertically and exposed to salt spray (fog) as specified in Salt Spray (Fog) Testing, ASTM B117-94, 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°C).

28.6 The samples are to be exposed to a moist hydrogen sulfide air mixture in a closed glass chamber for 10 days at an ambient temperature of $75 \pm 5^\circ\text{F}$ ($24 \pm 3^\circ\text{C}$). On 5 days out of every 7, 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 2 days out of every 7 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 m³ of chamber volume) is to be maintained at the bottom of the chamber for humidity.

28.7 The samples are to be exposed to a moist carbon dioxide-sulfur dioxide air mixture in a closed glass chamber for 10 days at an ambient temperature of $75 \pm 5^\circ\text{F}$ ($24 \pm 3^\circ\text{C}$). On 5 days out of every 7, 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, is 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 2 days out of every 7 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 m³ of chamber volume) is to be maintained at the bottom of the chamber for humidity.

29 30-Day Corrosion Test

29.1 The external parts of an ESFR 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 separate groups of samples in accordance with 28.4 – 28.7 for a period of 30 days. Following the exposure, each sample shall be subjected to and comply with the Sensitivity Test, Section 18.

29.2 During the corrosive exposure, the inlet thread orifice is to be sealed by a plastic cap after the sprinkler has been filled with deionized water and provision taken to prevent condensation from falling onto the test samples.

29.3 Each sample is to be subjected to the Sensitivity Test, Section 18, within 1 to 5 days following the exposure period.

30 90-Day Moist Air Test

30.1 An ESFR sprinkler shall withstand an exposure to high temperature-humidity in accordance with 30.2 for a period of 90 days. Following the exposure, each sprinkler shall operate at a service pressure of 5 psig (34 kPa) within 5 seconds after operation of the heat responsive element.

30.2 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 $203 \pm 2^{\circ}\text{F}$ ($95 \pm 1^{\circ}\text{C}$) and the humidity is to be 98 ± 2 percent. Ordinary and intermediate temperature-rated sprinklers shall have, for the temperature-humidity chamber exposure only, special heat responsive elements to withstand the elevated temperature.

30.3 After the exposure, each sample is to be installed on piping and supplied with water at a service pressure of 5 psig (34 kPa). Each sprinkler is to be activated by exposing the heat responsive element to a uniform application of heat. The operating parts shall clear the sprinkler frame and deflector within 5 seconds after operation of the heat responsive element.

31 Stress-Corrosion Cracking of Brass Sprinkler Parts Test

31.1 After being subjected for 10 days to a moist ammonia exposure as described in 31.2 and 31.3 a sprinkler having brass parts shall:

- a) Show no evidence of cracking, delamination, or degradation; or
- b) Demonstrate acceptable performance.

If 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 31.4 and 31.5.

31.2 Five samples are to be degreased and then exposed for 10 days to a moist ammonia-air mixture maintained in a glass chamber approximately 12 by 12 by 12 inches (305 by 305 by 305 mm) having a glass cover. Provisions are to be taken to prevent condensation from falling onto the test samples.