

**OTHER
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DOCUMENT**

ULC/ORD-C1767-03

EARLY-SUPPRESSION FAST-RESPONSE SPRINKLERS



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EARLY-SUPPRESSION FAST-RESPONSE SPRINKLERS

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TABLE OF CONTENTS

FOREWORD.....	i
REFERENCE PUBLICATIONS	ii
PREFACE	1
1. SCOPE.....	2
2. GENERAL.....	2
3. GLOSSARY	2
4. CONSTRUCTION	3
4.1 GENERAL	3
4.2 INLET THREADS.....	3
4.3 TEMPERATURE RATINGS, CLASSIFICATIONS, AND COLOR CODINGS	4
4.4 NOMINAL “K _m ” FACTORS	4
4.5 COATINGS AND PLATINGS	4
4.6 PROTECTIVE COVERS	4
5. PERFORMANCE	5
5.1 GENERAL	5
5.2 SAMPLES	5
5.3 LOAD ON HEAT RESPONSIVE ELEMENT TEST	5
5.4 STRENGTH OF HEAT RESPONSIVE ELEMENT TEST	5
5.4.1 Fusible-alloy types	5
5.4.2 Frangible-bulb types	6
5.5 LEAKAGE TEST	6
5.6 HYDROSTATIC STRENGTH TEST	7
5.7 30 DAY LEAKAGE TEST.....	7
5.8 WATER HAMMER TEST	7
5.9 OPERATING TEMPERATURE (BATH) TEST	8
5.10 SENSITIVITY TEST	9
5.11 OPERATION - LODGEMENT TEST	10
5.12 FLOW ENDURANCE TEST	10
5.13 OPERATION - COLD SOLDERING TEST	10
5.14 HIGH TEMPERATURE TEST	11
5.15 STRENGTH OF FRAME TEST.....	11
5.16 IMPACT RESISTANCE TEST	12
5.17 VIBRATION TEST.....	12
5.18 CALIBRATION TEST	12
5.19 ACTUAL DELIVERED DENSITY (ADD) TEST	13
5.20 10-DAY CORROSION TEST	14
5.21 30-DAY CORROSION TEST	15
5.22 90-DAY MOIST AIR TEST	15
5.23 STRESS-CORROSION CRACKING OF BRASS SPRINKLER PARTS TEST	15
5.24 STRESS-CORROSION CRACKING OF STAINLESS STEEL PARTS TEST	16
5.25 EXPOSURE TESTS ON SPRINKLERS INCORPORATING POLYMERIC GASKETS.....	17
5.25.1 General	17
5.25.2 Corrosive exposures	17
5.25.3 Temperature cycling exposure	17
5.25.4 Hydrocarbon exposure followed by moist air exposure	18
5.25.5 Hydrocarbon exposure followed by water immersion exposure	18
5.25.6 Exposure to antifreeze solutions.....	18
5.26 DEZINCIFICATION TEST OF BRASS PARTS.....	19
5.26.1 General	19

5.26.2 Reagent	19
5.26.3 Test Pieces	19
5.26.4 Method	19
5.27 ELASTOMERIC PARTS TEST	20
5.28 ROUGH USAGE TEST	20
5.29 IMPACT TEST FOR PROTECTIVE COVERS	21
5.30 THERMAL SHOCK TEST	21
5.31 VACUUM TEST	21
5.32 FREEZING TEST	22
5.33 EVAPORATION TEST FOR SPRINKLER COATINGS	22
5.34 DISTRIBUTION TESTS FOR ESFR SPRINKLERS FOR USE IN BUILDINGS UP TO 12.2 M IN HEIGHT	22
5.35 THRUST FORCE TEST FOR ESFR SPRINKLERS FOR USE IN BUILDINGS UP TO 12.2 M IN HEIGHT	23
6. MARKING	23
6.1 GENERAL	23
7. MANUFACTURING AND PRODUCTION TESTS	24
7.1 GENERAL	24
7.2 PRODUCTION LEAKAGE TEST	24
7.3 FRANGIBLE BULB INTEGRITY TEST	24
TABLES	26
FIGURES	29
APPENDIX A – (INFORMATIVE) TOLERANCE LIMIT CALCULATION METHODS	41
A1 General	41

FOREWORD

Certification organizations are periodically requested to promptly provide certification services for devices, constructions, materials and systems where Canadian recognized standards do not currently exist or are not entirely applicable. Accordingly, the certification organization utilizes its experience, existing specifications and requirements in related areas, together with assistance from its advisory councils to develop and prepare Other Recognized Documents (ORDs) for use in conducting the necessary tests and evaluation investigation.

Underwriters' Laboratories of Canada has prepared many ORDs, which are consensus documents, in response to requests from, and in conjunction with, industry, code writing bodies, regulatory agencies and others prior to promulgating a certification program. In many instances such documents have become published ULC Standards and subsequently National Standards of Canada. It is the intention of Underwriters' Laboratories of Canada to continue this practice, as appropriate.

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REFERENCE PUBLICATIONS

The documents shown below are referenced in the text of this ORD. Unless otherwise stated elsewhere in this ORD such reference shall be considered to indicate the edition and/or revisions of the document available at the date on which this ORD was approved.

Documents Published by the American Society of Mechanical Engineers (ASME)
Three Park Avenue, New York NY 10016-5990 U.S.A.
Telephone: 800-843-2763
www.asme.org

- ANSI/ASME B1.20.1-1983(R1992), Standard for Pipe Threads, General Purpose (Inch)
-

Documents Published by the American Society for Testing and Materials (ASTM)
100 Barr Harbour Drive, PO Box C700, West Conshohocken, PA 19428-2959 U.S.A.
Telephone: (610) 832-9585
www.astm.org

- ASTM B117-02, Standard Practice for Operating Salt Spray (Fog) Apparatus
 - ASTM E1-01, Standard Specification for ASTM Thermometers
-

Document Published by the National Fire Protection Association (NFPA)
1 Batterymarch Park, Quincy, MA 02169-7471 U.S.A.
Telephone: (617) 770-3000
www.nfpa.org

- NFPA 13, Standard for the Installation of Sprinkler Systems (2002)
-

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- UL 157, Gaskets and Seals
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EARLY-SUPPRESSION FAST-RESPONSE SPRINKLERS

PREFACE

This is the First Edition of Early-suppression Fast-response Sprinklers, ULC/ORD-C1767-03.

A product which complies with these requirements will not necessarily be acceptable if, when examined and tested, it is found to have features not covered by the ORD which may impair the result contemplated by these requirements.

A product employing materials or having forms of construction differing from those detailed in these requirements may be examined and tested according to the intent of the requirements, and if found to be substantially equivalent, may be given recognition.

Only metric SI units of measurement are used in this ORD. If a value for measurement is followed by a value in other units in parentheses, the second value may be approximate. The first stated value is the requirement.

Appendix A, identified as informative, is for informational purposes only.

Attention is drawn to the possibility that some of the elements of this Recognized Document may be the subject of patents rights. Underwriters' Laboratories of Canada shall not be held responsible for identifying any or all such patents rights.

Requests for interpretation of this ORD should be sent to the Standards Department of Underwriters' Laboratories of Canada. The requests should be worded in such a manner as to permit a "yes" or "no" answer based on the literal text of the requirement concerned.



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.

2. GENERAL

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

3. GLOSSARY

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

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

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

DELIVERED DENSITY - The rate of water discharge from a sprinkler onto the top of a protected horizontal surface under a non-fire condition.

DISCHARGE COEFFICIENT " K_m " - Coefficient of discharge in the formula:

$$K_m = \frac{Q}{\sqrt{p}}$$

in which:

Q is the flow in L/min; and

p is the pressure in MPa.

Note: K_m is a metric Constant and is approximately equivalent to 1.44K, where K is the corresponding Imperial Constant in US $\frac{gpm}{\sqrt{psi}}$

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).

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.

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.

OPERATING TEMPERATURE - The temperature at which the *heat responsive element* of a sprinkler operates when subjected to a 0.5°C per minute temperature rise while immersed in a liquid bath.

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

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*.

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*.

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

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. CONSTRUCTION

4.1 GENERAL

4.1.1 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 34 to 1210 kPa. 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).

4.1.2 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.

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

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

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

4.2 INLET THREADS

4.2.1 The inlet end of an ESFR sprinkler, if threaded, shall be provided with 19 mm 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(R1992).

4.2.2 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.

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

4.3 TEMPERATURE RATINGS, CLASSIFICATIONS, AND COLOR CODINGS

4.3.1 The temperature ratings, classifications, and colour coding of the frame arms or frangible bulb *heat responsive elements* of an ESFR sprinkler shall be as specified in Table 1.

4.4 NOMINAL " K_m " FACTORS

4.4.1 An ESFR sprinkler shall have a " K_m " factor as specified in Table 2. The nominal " K_m " factor is to be determined from the *discharge coefficient* " K_m ", as specified by the Calibration Test, Section 5.18.

4.4.2 An ESFR sprinkler shall have a mean " K_m " factor that is within the *discharge coefficient* range specified in Table 2, as determined by the Calibration Test, Section 5.18.

4.4.3 The diameter of a discharge *orifice* or any internal passage of an ESFR sprinkler shall be at least 9.5 mm.

4.5 COATINGS AND PLATINGS

4.5.1 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.

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

4.5.3 A coating shall not be brittle when new nor become brittle with age as specified by the Evaporation Test for Sprinkler Coatings, Section 5.33.

4.5.4 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 5.14.

4.6 PROTECTIVE COVERS

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

4.6.2 Sprinklers required to be equipped with sprinkler covers shall comply with Section 5.29, Impact Test for Protective Covers, and 6.1.11.

5. PERFORMANCE

5.1 GENERAL

5.1.1 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 5.3 – 5.35.

5.2 SAMPLES

5.2.1 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.

5.3 LOAD ON HEAT RESPONSIVE ELEMENT TEST

5.3.1 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 5.4.

5.3.2 At least 25 samples 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.

5.4 STRENGTH OF HEAT RESPONSIVE ELEMENT TEST

5.4.1 Fusible-alloy types

5.4.1.1 A *heat responsive element* of an ESFR sprinkler shall either:

- A Sustain a load of 15 times its maximum design load for 100 hours; or
- B Demonstrate the ability to sustain the maximum design load when tested in accordance with 5.4.1.2 and 5.4.1.3.

5.4.1.2 Compliance with 5.4.1.1 is to be determined by subjecting at least ten sample *heat responsive elements* to a load of 15 times the maximum design load for at least 100 hours. Compliance with 5.4.1.1(B) is to be determined by subjecting sample heat-responsive elements to loads in excess of the maximum design load. A minimum of 15 samples are to be loaded at various values as required up to 15 times the design load. At least one test load value shall produce a *heat responsive element* failure time greater than 1000 hours. These load and failure time values are then to 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:

$$L_d \leq \frac{1.02 L_m^2}{L_o}$$

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.

5.4.1.3 The load tests are to be conducted at an ambient temperature of $21 \pm 3^\circ\text{C}$.

5.4.2 Frangible-bulb types

5.4.2.1 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 can be 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 25 kg/s pounds-force or 1.27 mm/min. 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.

5.4.2.2 An ESFR sprinkler having a frangible bulb shall withstand the thermal shock of rapid temperature changes 11°C below its marked *operating temperature* or 11°C below the lowest allowable value of the *operating temperature* range determined in the Operating Temperature (Bath) Test, Section 5.9, whichever is lower. At least five samples are to be conditioned for 5 minutes in a liquid bath at 11°C less than their rated *operating temperature* or minimum permitted *operating temperature*. The samples are then to be removed and immediately submerged in another liquid bath at 10°C . There shall be no breakage or fracture of the frangible bulb. This sequence is to be conducted three times.

5.5 LEAKAGE TEST

5.5.1 An ESFR sprinkler shall not exhibit any leakage at any pressure from 0 - 3.45 MPa when tested as described in 5.5.2 and 5.5.3.

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

5.5.3 The pressure is to be increased from 0 to 3.45 MPa at a rate not exceeding 2.0 MPa per minute and held for 1 minute. During this phase, there shall be no visible leakage in any sample.

5.6 HYDROSTATIC STRENGTH TEST

5.6.1 An ESFR sprinkler shall withstand, for 1 minute, without rupture, an internal hydrostatic pressure of 4.83 MPa when tested in accordance with Clause 5.6.2.

5.6.2 Twenty samples are to be individually tested. The pressure is to be increased from 0 to 4.83 MPa at a rate not exceeding 2.0 MPa per minute. The pressure is to be maintained at 4.83 MPa 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 4.8 MPa for 1 minute.

5.7 30 DAY LEAKAGE TEST

5.7.1 When tested as described in 5.7.2 – 5.7.4, an ESFR sprinkler shall:

- A Experience no leakage when subjected to a hydrostatic pressure of 2.07 MPa for 30 days;
- B Not leak when subjected to a pressure of 3.45 MPa or less for 1 minute following the 30 days;
- C Show no distortion or other mechanical damage following the leakage testing, as determined by visual examination.

5.7.2 Five samples are to be installed on a water-filled manifold maintained under a constant pressure of 2.0 MPa for 30 days. The samples are to be examined weekly during the test period for evidence of leakage of water at the closure cap.

5.7.3 Following completion of this 30-day test period, the samples are to be tested to verify that they do not leak at a pressure of 3.45 MPa or less. The pressure is to be increased from 0 to 3.45 MPa at a rate not exceeding 2.0 MPa per minute. The pressure is to be maintained at 3.45 MPa for 1 minute, and is then to be decreased to 0 Pa at a rate not exceeding 2.0 MPa per minute.

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

5.8 WATER HAMMER TEST

5.8.1 When tested as described in 5.8.2 – 5.8.5, an ESFR sprinkler shall:

- A Experience no leakage when subjected to 100,000 applications of a pressure surge increasing rapidly from 345 kPa to 3.45 MPa;
- B Not leak when subjected to a pressure of 3.45 MPa or less for 1 minute, following the 100,000 cycles of water hammer; and

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

5.8.2 Five samples are to be installed on a water-filled test line connecting with a small motor-operated piston pump that produces pressure cycles from 345 kPa to 3.45 MPa to 345 kPa. Each cycle is to be completed within 1 second. 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.

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

5.8.4 Following completion of the pressure cycling, the samples are to be tested to verify that they do not leak at 3.45 MPa or less. The pressure is to be increased from 0 to 3.45 MPa at a rate not exceeding 2.0 MPa per minute. The pressure is to be maintained at 3.45 MPa for 1 minute, and is then to be decreased to 0 MPa at a rate not exceeding 2.0 MPa per minute.

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

5.9 OPERATING TEMPERATURE (BATH) TEST

5.9.1 The *operating temperature* of ESFR sprinklers, when bath tested in accordance with Clauses 5.9.2 through 5.9.7, shall be within a range of ± 3.5 percent of its marked temperature rating.

5.9.2 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*.

5.9.3 At least ten samples of each type of sprinkler produced, including plated, coated, and uncoated types, as applicable, are to be subjected to this test.

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

5.9.5 Water is to be used in bath tests of sprinklers that have *operating temperature* ratings of 68 to 79°C. Samples having *operating temperature* ratings of 80 to 104°C are to be bath-tested in an oil having a flash point exceeding the test temperature.

5.9.6 A laboratory mercury thermometer, having 0.5°C markings and calibrated in accordance with the Standard Specification for ASTM Thermometers, ASTM E1-01, is to be used to determine temperatures of the liquid employed in the bath tests. The bulb of the thermometer is to be held level with the sprinkler operating parts by a support member.