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DOCUMENT**

ULC/ORD-C2351-03

SPRAY NOZZLES FOR FIRE-PROTECTION SERVICE



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SPRAY NOZZLES FOR FIRE-PROTECTION SERVICE

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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.

Comments on the content of this ORD should be directed to the Head Office of Underwriters' Laboratories of Canada, 7 Underwriters Road, Toronto, Ontario, Canada M1R 3B4

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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.

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

- 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
-

Documents 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)
 - NFPA-15, Standard for Water Spray Fixed Systems for Fire Protection
-

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SPRAY NOZZLES FOR FIRE-PROTECTION SERVICE

PREFACE

This is the First Edition of Spray Nozzles for Fire-Protection Service, ULC/ORD-C2351-03.

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.

Appendices A and B, identified as informative, are 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 automatic and *non-automatic (open)* type water spray nozzles for installation in accordance with the Standard for Installation of Sprinkler Systems, NFPA 13, and the Standard for Water Spray Fixed Systems for Fire Protection, NFPA 15. Nozzles are categorized by the *discharge coefficient* " K_m " of the *orifice*, water discharge angle or pattern, type of coating or plating, and other factors that have a bearing on their application. *Automatic nozzles* are also categorized by *operating temperature* rating.

2. GLOSSARY

2.1 GENERAL

NOTE: Terms used in this Standard that are in italics are defined as follows:

AUTOMATIC NOZZLE - A nozzle intended to open automatically by operation of a heat-responsive element that maintains the discharge *orifice* closed by means such as the exertion of force on a cap (button or disc). A nozzle is installed on piping so that a spray of water is discharged in a specific pattern for suppression or control of fires, or protection from fire exposure.

COATED, PAINTED, OR PLATED NOZZLE - A nozzle that has factory applied coatings, paint, or platings for corrosion protection or decorative purposes.

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 kPa

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

DISCHARGE PRESSURE RANGE - The *pressure range* corresponding to the specified minimum and maximum pressures at which the spray nozzle is intended to be discharged.

HEAT RESPONSIVE ELEMENT - That portion of an *automatic nozzle* that breaks, melts, or otherwise functions to initiate the automatic operation of the nozzle when exposed to sufficient heat.

MANUAL MEANS OF ACTUATION - A means of system actuation in which the system operator initiates system discharge.

NON-AUTOMATIC (OPEN) NOZZLE - A nozzle that discharges water immediately when water is supplied from the water control valve. A *non-automatic nozzle* may be an *automatic nozzle* with the heat responsive and activating elements removed. The discharge *orifice* is open.

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

ORIFICE - The opening that controls the amount of water discharged from a nozzle at a given pressure.

QUICK RESPONSE (QR) NOZZLE - A nozzle that complies with the applicable requirements for such nozzles in the Sensitivity Tests, Section 4.10.

3. CONSTRUCTION

3.1 GENERAL

3.1.1 An *automatic nozzle* 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 34 kPa to the rated pressure.

3.1.2 The closure of the water seat shall not be achieved by the use of a dynamic “O” ring or similar seal. (i.e. an O-ring or similar seal that moves during operation or is in contact with a component that moves during operation.)

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

3.1.4 An *automatic nozzle* 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 nozzle.

3.1.5 Nozzle types or materials not anticipated by these requirements require additional evaluation, such as tests to investigate special metallic or non-metallic materials.

3.2 INLET THREADS

3.2.1 Nozzles shall be provided with external pipe threads at the inlet end as specified in Table 1. Inlet-end pipe threads shall comply with the Standard for Pipe Threads, General Purpose (Inch), ASME B1.20.1-1983 (R1992).

3.2.2 Nozzles shall be permitted to be provided with 19 or 25.4 mm external NPT pipe threads for *orifice* sizes larger than those specified in Table 1.

3.2.3 Internal taper pipe threads (NPT) of 19 or 25.4 mm size shall be permitted to be used for nozzles with K_m -factors of 11.6 or greater in lieu of those specified in Table 1.

3.2.4 Nozzles intended for use in installations where fittings incorporate 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.

3.2.5 Nozzle inlets intended for attachment to piping by means other than threads are able to be used when the nozzles are intended to be attached in a manner that does not involve welding and that permits nozzle removal from the piping without the use of special tools or torch cutting equipment.

3.2.6 Threads shall be cleanly cut and true and free from burrs, scoring or chatter marks.

3.3 TEMPERATURE RATINGS

3.3.1 The temperature ratings and temperature classifications of automatic spray nozzles shall be as specified in Table 2. The frame arms of the automatic spray nozzles or frangible bulb *heat responsive element* shall be coloured according to the colour code specified in Table 2.

3.4 COATING AND PAINTING

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

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

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

3.5 PRESSURE RATING

3.5.1 Nozzles shall have a rated pressure of 1.21 MPa, 1.72 MPa, or 2.07 MPa.

4. PERFORMANCE

4.1 GENERAL

4.1.1 To determine compliance with these requirements, the various types and spray patterns of a nozzle shall be subjected to the performance tests described in Sections 4.3 – 4.30.

4.2 SAMPLES

4.2.1 The number of samples required for investigation varies for different nozzle 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.

4.3 LOAD ON HEAT RESPONSIVE ELEMENT TEST

4.3.1 For *automatic nozzles* 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 pressure to the inlet end of the nozzle 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 4.4.

4.3.2 At least 25 nozzles 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.

4.4 STRENGTH OF HEAT RESPONSIVE ELEMENT TEST

4.4.1 Fusible-alloy types

4.4.1.1 For *automatic nozzles*, a *heat responsive element* in the ordinary temperature rating (see Table 2) 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 4.4.1.2 and 4.4.1.3.

4.4.1.2 Compliance with 4.4.1.1 (B) is to be determined by subjecting sample heat-responsive elements to loads in excess of the maximum design load. A minimum of 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 (Refer also to Appendix B):

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

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.

4.4.1.3 The test samples are to be loaded at a conditioned temperature of $21 \pm 3^\circ\text{C}$.

4.4.2 Frangible-bulb types

4.4.2.1 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 nozzle 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 25 kg/s, or at a rate that deflects the bulb 0.5 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.

4.4.2.2 A nozzle 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 4.9, whichever is lower. At least five samples of the nozzle 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 then are to be removed and immediately submerged in another liquid bath at 10°C. The frangible bulb shall not break or fracture.

4.5 LEAKAGE TEST

4.5.1 When tested as described in 4.5.2 and 4.5.3, an *automatic nozzle* shall not exhibit leakage at any pressure from 0 kPa to the applicable leakage test pressure shown in Table 3.

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

4.5.3 The pressure is to be increased from 0 kPa to the test pressure at a rate not exceeding 2.0 MPa per minute and then held for 1 minute. There shall be no visible leakage in any sample.

4.6 HYDROSTATIC STRENGTH TEST

4.6.1 An *automatic nozzle* shall withstand, for 1 minute, without rupture, an internal hydrostatic pressure equal to the hydrostatic test pressure shown in Table 3.

4.6.2 At least 20 samples are to be individually tested. The nozzle inlets are to be filled with water and vented of air. The pressure is to be increased from 0 kPa to the hydrostatic test pressure shown in Table 3 at a rate not exceeding 2.0 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.

4.7 30-DAY LEAKAGE TEST

4.7.1 When tested as described in 4.7.2 – 4.7.3, an *automatic nozzle* shall:

- A Experience no leakage when subjected to the 30 day test pressure specified in Table 4 for 30 days;
- B Not leak when subjected to the leakage test pressure specified in Table 3 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.

4.7.2 Five samples are to be installed on a water-filled test line maintained under a constant test pressure as specified in Table 4 for 30 days. The samples are to be examined weekly during the test period for evidence of leakage of water at the closure cap.

4.7.3 Following completion of this 30-day test period, the samples are to be subjected to the Leakage Test specified in 4.5.1. The samples shall be examined for distortion or mechanical damage.

4.8 WATER HAMMER TEST

4.8.1 When tested as described in 4.8.2 – 4.8.3, an *automatic nozzle* shall:

- A Experience no leakage when subjected to 3,000 applications of pressure surges having a test pressure range as specified in Table 5;
- B Not leak when subjected to the leakage test pressure specified in Table 4 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.

4.8.2 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 5 at the rate of 60 cycles per minute. The test piping is to be filled so that there is water at the nozzle seat, and the pump is to be placed in operation and adjusted to produce the specified test-pressure cycle.

4.8.3 Following completion of the pressure cycling, the samples are to be subjected to the Leakage Test as specified in 4.5.1. The samples are then to be examined for distortion or mechanical damage.

4.9 OPERATING TEMPERATURE (BATH) TEST

4.9.1 The *operating temperature of automatic nozzles*, when bath tested, shall be within a range having a maximum temperature not in excess of either 5°C or ±3.5 percent of the marked nominal temperature, whichever is greater.

4.9.2 Nozzle 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

