



UL 2351

Underwriters Laboratories Inc. Standard for Safety

Spray Nozzles for Fire- Protection Service



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UL Standard for Safety for Spray Nozzles for Fire-Protection Service, UL 2351

Second Edition, Dated June 4, 2004

Revisions: This Standard contains revisions through and including February 24, 2009.

Summary of Topics

These revision to ANSI/UL 2351 include the following changes in requirements:

Revision of the "Operation - Lodgement Test" in Section 22

Dynamic O-ring Water Seals

Inlet Threads

Integral Strainers

Revisions to More Closely Align Text with UL 199, Clarify Requirements And Update Testing Details

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
February 24, 2011	7.1, 10A.1, 22.1, and 22.2; Table 7.1, Table 22.1, and Figure 22.1

The new and revised requirements are substantially in accordance with UL's Proposal(s) on this subject dated October 31, 2008.

The revisions dated February 24, 2009 include a reprinted title page (page1) for this Standard.

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://ulstandardsinfo.net/ulforeword.html>

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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.

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

Page	Date
1-4	February 24, 2009
5-6	June 4, 2004
7-12	February 24, 2009
13-18	June 4, 2004
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26-28	June 4, 2004
29-40B	February 24, 2009
41-42	June 4, 2004
SA1-SA2	June 4, 2004
SA3	February 24, 2009
SA4	June 4, 2004
SB1	June 4, 2004
SB2	February 24, 2009
SR1-SR2	February 24, 2009

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UL/ANSI 2351-2009

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UL 2351

Standard for Spray Nozzles for Fire-Protection Service

First Edition – July, 2000

Second Edition

June 4, 2004

This ANSI/UL Standard for Safety consists of the Second edition including revisions through February 24, 2009.

The most recent designation of ANSI/UL 2351 as an American National Standard (ANSI) occurred on February 23, 2009. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

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INTRODUCTION

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.

1.2 Nozzles are categorized by the discharge coefficient "K" 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 Components

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

2.2 A component is not required to comply with a specific requirement that:

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

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

2.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

3 Units of Measurement

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

4 Undated References

4.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

5 Glossary

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

5.2 **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.

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

5.4 **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 × 15.85), and

P is the pressure in pounds per square inch gauge (psig) (bar × 14.5).

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

5.6 **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.

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

5.8 **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.

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

5.10 **ORIFICE** – The outlet that controls the amount of water discharged from a nozzle at a given pressure.

5.11 **QUICK RESPONSE (QR) NOZZLE** – A nozzle that complies with the applicable requirements for such nozzles in the Sensitivity Tests, Section 21.

CONSTRUCTION

6 General

6.1 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 as specified in this standard. 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).

6.1 revised February 24, 2009

6.2 Stampings shall show no cracking or splitting and shall be uniformly smooth and cleanly cut.

6.3 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.

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

6.5 Sample spray nozzles are to be constructed in accordance with the manufacturer's detailed drawings including materials, dimensions, and tolerances.

7 Inlet Threads

7.1 Nozzles shall be provided with not less than 1/4 inch external NPT pipe threads at the inlet that comply with the Standard for Pipe Threads, General Purpose (Inch), ASME B1.20.1.

Exception No. 1: Nozzles intended for use in installations where fittings incorporate other than NPT threads, shall be permitted with pipe threads complying with a national pipe thread standard compatible with those fittings.

Exception No. 2: 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.

Revised 7.1 effective February 24, 2011

Table 7.1
Discharge coefficient "K" and thread-type

Table 7.1 deleted effective February 24, 2011

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

8 Temperature Ratings

8.1 The temperature ratings, temperature classifications, and color coding of automatic spray nozzles shall be as specified in Table 8.1. The frame arms of the automatic spray nozzles or glass bulb heat responsive element shall be colored according to the color code specified in Table 8.1.

8.1 revised February 24, 2009

Table 8.1
Temperature classification ratings and color coding

Table 8.1 revised February 24, 2009

Temperature classification	Temperature rating		Color coded		Maximum ambient temperature	
	°F	(°C)	Frame arms	glass bulb	°F	(°C)
Ordinary	135 – 170	(57 – 77)	Uncolored or Black	Orange -135°F (57°C) or Red -155°F (68°C)	100	(38)
Intermediate	175 – 225	(79 – 107)	White	Yellow -175°F (68°C) or Green -200°F (57°C)	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)

9 Coatings and Platings

9.1 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.

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.

10 Pressure Rating

10.1 Nozzles shall have a rated pressure of 175 psig (12.1 bar), 250 psig (17.2 bar), or 300 psig (20.7 bar).

10A Strainer

10A.1 A nozzle having a water passageway less than 3/16 inch (5 mm) shall be provided with a strainer or filter constructed of a corrosion resistant material. The maximum dimension of an opening in the strainer or filter shall not exceed 80 percent of the smallest water passageway being protected.

Added 10A.1 effective February 24, 2011

11 Protective Covers

11.1 Automatic nozzles 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 spray nozzle system is placed in service.

Exception: Certain automatic nozzle designs that are constructed to provide protection for the glass bulb during handling, such as nozzles with guards, may not be required to have protective covers.

11.1 effective December 4, 2005

11.2 Automatic nozzles required to be equipped with protective covers shall comply with Section 30, Impact Test for Protective Covers, and 46.2.

11.2 effective December 4, 2005

PERFORMANCE

12 General

12.1 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 14 – 42.

13 Samples

13.1 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.

14 Load on Heat Responsive Element

14.1 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, are 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 15.

14.1 revised February 24, 2009

14.2 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.

15 Strength of Heat Responsive Element Test

15.1 Fusible-alloy types

15.1.1 For automatic nozzles, a heat responsive element in the ordinary temperature rating, see Table 8.1, 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 15.1.2 and 15.1.3.

15.1.2 Compliance with 15.1.1(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 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 equation:

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

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.

15.1.3 The test samples are to be loaded at a conditioned temperature of $70 \pm 5^{\circ}\text{F}$ ($21 \pm 3^{\circ}\text{C}$).

15.2 Glass-bulb types

15.2.1 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 nozzle 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 are capable of being 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 Supplement SA, Tolerance limit calculation method.

15.2.2 Deleted February 24, 2009

15A Glass-Bulb Thermal Shock Test

15A.1 An automatic nozzle having a glass bulb shall withstand the thermal shock of rapid temperature changes when tested as specified in 15A.2 without breakage or fracture of the glass bulb.

15A.1 added February 24, 2009

15A.2 At least five sample nozzles are to be conditioned for 5 minutes in a liquid bath at 20°F (11°C) less than the marked temperature rating. The samples then are to be removed and immediately submerged in another liquid bath at 50°F (10°C). The bulb of each nozzle shall be visually observed for signs of breakage or fracture.

15A.2 added February 24, 2009

16 Leakage Test

16.1 When tested as described in 16.2 and 16.3, an automatic nozzle shall not exhibit leakage at any pressure from 0 psig to the applicable leakage test pressure shown in Table 16.1.

Table 16.1
Test pressures for the leakage and hydrostatic tests

Rated pressure		Leakage test pressure		Hydrostatic test pressure	
psig	(bar)	psig	(bar)	psig	(bar)
175	(12.1)	500	(34)	700	(48)
250	(17.2)	500	(34)	1000	(69)
300	(20.7)	600	(41)	1200	(83)

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

16.3 The pressure is to be increased from 0 psig to the test pressure at a rate not exceeding 300 psig (20.7 bar) per minute and then held for 1 minute. There shall be no visible leakage in any sample.

17 Hydrostatic Strength Test

17.1 An automatic nozzle shall withstand, for 1 minute, without rupture, an internal hydrostatic pressure equal to the hydrostatic test pressure shown in Table 16.1.

17.2 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 psig to the hydrostatic test pressure shown in Table 16.1 at a rate not exceeding 300 psig (20.7 bar) 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.

18 30-Day Leakage Test

18.1 When tested as described in 18.2 and 18.3, an automatic nozzle shall:

- Experience no leakage when subjected to the 30 day test pressure specified in Table 18.1 for 30 days;
- Not leak when subjected to the leakage test pressure specified in Table 16.1 or less for 1 minute following the 30 days; and
- Show no distortion or other mechanical damage following the leakage testing, specified in (b), as determined by visual examination.

Table 18.1
Test pressures for the 30-day leakage test

Rated pressure		30-day test pressure	
psig	(bar)	psig	(bar)
175	(12.1)	300	(20.7)
250	(17.2)	450	(31)
300	(20.7)	500	(34)

18.2 Five samples are to be installed on a water-filled test line maintained under a constant test pressure as specified in Table 18.1 for 30 days. The samples are to be examined weekly during the test period for evidence of leakage of water at the closure cap.

18.3 Following completion of this 30-day test period, the samples are to be subjected to the leakage test specified in 16.1. The samples shall be examined for distortion or mechanical damage.

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