



UL 2167

STANDARD FOR SAFETY

Water Mist Nozzles for Fire Protection Service

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UL Standard for Safety for Water Mist Nozzles for Fire Protection Service, UL 2167

Second Edition, Dated March 9, 2021

Summary of Topics

This new edition of ANSI/UL 2167 has been updated to incorporate the ANSI approval of March 9, 2021. The new edition also includes the following:

- Revisions to Clarify Requirement, Enhance Alignment With UL Sprinkler Standards, And Update Testing Details***
- Hydrostatic Strength***
- Revisions to Shipboard Light and Ordinary Hazard Area Fire Tests***
- Light Hazard Area Fire Test***
- Revisions to Performance Based Acceptance Criteria for Ordinary Hazard Fire Tests and Installation Instructions***

The requirements are substantially in accordance with Proposal(s) on this subject dated September 11, 2020.

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ANSI/UL 2167-2021

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UL 2167

Standard for Water Mist Nozzles for Fire Protection Service

First Edition – December, 2002

Second Edition

March 9, 2021

This ANSI/UL Standard for Safety consists of the Second Edition.

The most recent designation of ANSI/UL 2167 as an American National Standard (ANSI) occurred on March 9, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

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INTRODUCTION

1 Scope

1.1 This Standard contains requirements for water mist nozzles for use with water mist fire-protection systems intended for the protection of residential, light and ordinary hazard areas as well as shipboard machinery, control spaces, service areas, and public spaces. The intended application and use of a water mist nozzle is referenced in the Manufacturer's Design and Installation Instructions. See Section [49](#), Design and Installation Instructions.

1.2 This Standard is intended to address minimum fire-protection performance, construction, and marking requirements for water mist nozzles.

2 Units of Measurement

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

3 Components

3.1 Except as indicated in [3.2](#), a component of a product covered by this standard shall comply with the requirements for that component.

3.2 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.

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

3.4 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 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 CONDUCTIVITY FACTOR – A measure of the conductance between the nozzle's heat responsive element and the fitting expressed in units of (m/s)^{0.5}.

5.3 CONTROL SPACES – Shipboard areas such as the bridge, radio room, and emergency power room.

5.4 CORROSION RESISTANT MATERIAL – A material (such as bronze, brass, stainless steel, or plastic) which has a low propensity for corrosion when used in its anticipated application.

- 5.5 DESIGN LOAD – The force exerted on the release element at the service load of the nozzle.
- 5.6 ENGINEERED WATER MIST SYSTEMS – A system which requires individual design and calculation to determine the flow rates, nozzle pressures, pipe size, area or volume protected by each nozzle, discharge density, the number and type of nozzles, and the nozzle placement in order to protect a specific hazard.
- 5.7 FIRE CONTROL – Limiting the growth of a fire and controlling ceiling gas temperatures to prevent structural damage.
- 5.8 FIRE SUPPRESSION – The sharp reduction of the heat release of a fire and the prevention of its regrowth.
- 5.9 FLAME SPREAD INDEX (FSI) – A fire spread characteristic measured in accordance with the Standard for Test for Surface Burning Characteristics of Building Materials, ANSI/UL 723.
- 5.10 FLASHOVER – A stage in the development of a contained fire in which all exposed surfaces reach ignition temperatures more or less simultaneously and fire spreads rapidly throughout the space.
- 5.11 FUEL PACKAGE – The combustible materials in which the fire is ignited and also the combustible materials covering the walls and ceiling.
- 5.12 LIGHT HAZARD AREA – An area where the quantity or combustibility of its contents is low and where fires with low rates of heat release are expected.
- 5.13 MACHINERY SPACES – Shipboard engine rooms and cargo pump rooms containing combustible or flammable liquids having flammability characteristics no more severe than light diesel oil or heptane.
- 5.14 NOZZLES – The nozzles covered by this Standard are intended to generate water mist to control, extinguish, or suppress fire and consist of the following types:
- a) Automatic – A thermosensitive device designed to react at a predetermined temperature by automatically releasing water mist into a designated area or volume.
 - b) Coated – A nozzle which has a factory applied coating for corrosion protection.
 - c) Concealed – A recessed nozzle with a ceiling cover plate.
 - d) Flush – A nozzle in which all or part of the body, including the inlet thread, is mounted above the lower plane of the ceiling.
 - e) Fusible Element – A nozzle that opens under the influence of heat by the melting of a component.
 - f) Glass Bulb – A nozzle that opens under the influence of heat through pressure resulting from expansion of the enclosed fluid.
 - g) Hybrid – A nozzle that opens by the influence of heat or by an independent fire detection system.
 - h) Multiple Orifice – A nozzle having two or more outlet orifices.
 - i) Open – A nozzle without a thermosensitive element which discharges water mist.
 - j) Pendent – A nozzle that is arranged in such a way that water mist is directed downward by striking a distribution plate or by nozzle orientation.

- k) Pilot – A heat actuated nozzle which also controls the flow of water to one or more connected nozzles.
- l) Recessed – A nozzle of which all or part of the body, other than the inlet thread, is mounted within a recessed housing.
- m) Sidewall – A nozzle which is designed to be installed adjacent to a wall.
- n) Upright – A nozzle that is arranged in such a way that water mist is initially directed upwards against a distribution plate.
- 5.15 ORDINARY HAZARD GROUP 1 AREA – An area where the quantity and combustibility of the contents is moderate and where fires with moderate rates of heat release are expected.
- 5.16 ORDINARY HAZARD GROUP 2 AREA – An area where the quantity and combustibility of contents is moderate to high and where fires with moderate to high rates of heat release are expected.
- 5.17 PASSENGER CABINS – Shipboard areas with sleeping facilities assigned to passengers for their private use.
- 5.18 PRE-ENGINEERED WATER MIST SYSTEM – A system having predetermined flow rates, nozzle pressures, volumes, discharge patterns, and spray flux densities. These systems have specific pipe sizes, pipe lengths, flexible hose specifications, number of fittings, and number and type of nozzles prescribed in the manufacturer's design and installation instructions.
- 5.19 PRESSURE –
- a) MINIMUM FUNCTIONAL PRESSURE – The minimum pressure at which a nozzle intended to release its operating parts and allow for the discharge of water.
 - b) OPERATING PRESSURE – The pressure at which a nozzle is intended to operate to control, suppress or extinguish a fire.
 - c) RATED PRESSURE – Maximum service pressure at which a nozzle is intended to operate.
 - d) STANDBY PRESSURE – The pressure maintained in a water mist system under a non-fire or standby condition.
- 5.20 PUBLIC SPACES – Shipboard areas where people gather such as restaurants, dining rooms, lounges, corridors, and offices.
- 5.21 RESIDENTIAL AREA – A dwelling unit including hotel rooms, dormitory rooms, apartments, condominiums, sleeping rooms in nursing homes, and similar living units.
- 5.22 RESPONSE TIME INDEX (RTI) – A measure of nozzle sensitivity is expressed in units of $(m \cdot s)^{0.5}$. The RTI is used in combination with the conductivity factor (C) to predict the response of a nozzle in fire environments defined in terms of gas temperature and velocity versus time.
- 5.23 SERVICE LOAD – The combined force exerted on the nozzle body due to the assembly load of the nozzle and the equivalent force of the rated pressure applied at the inlet.
- 5.24 SERVICE SPACES – Shipboard areas where a ship's crew perform their duties, such as galleys, laundries, lockers, storerooms, and baggage rooms.

5.25 STANDARD ORIENTATION – The orientation in which the air flow is perpendicular to the axis of the nozzle's waterway and the plane of the frame arms, when provided, in order to produce the shortest response time.

5.26 WATER MIST FIRE SUPPRESSION SYSTEM – A fire-protection system consisting of a water supply, a water distribution system, and nozzles, in which the system is designed to discharge water mist from one or more nozzles in order to control or suppress a fire.

5.27 WORST CASE ORIENTATION – The orientation in which the axis of the nozzle waterway is perpendicular to the air flow, and the nozzle is positioned about this axis, in order to produce the longest response time.

CONSTRUCTION

6 General

6.1 All nozzles shall be made from corrosion resistant materials. Consideration shall be given to the effects of corrosive atmospheres, vibration, and intended use when materials are chosen.

6.2 The load on the heat responsive element in an automatic nozzle shall be set by the manufacturer in such a manner to prevent field adjustment or replacement. The nozzle orifice/deflector shall be permanently attached to the nozzle to prevent field adjustment or replacement.

6.3 A nozzle shall be provided with a nominal DN6 or 6 mm (0.25 inch) or larger inlet threads or pipe/tube/fitting arrangement. The dimensions of all threaded connections shall comply with international standards. When international standards are not applicable, national standards shall be used.

6.4 The omission of any single part or group of parts from a nozzle shall be obvious under normal, charged (non-operating) system conditions. (For example, leakage or discharge of water when the nozzle is subjected to normal operating pressures.)

6.5 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 the minimum functional pressure to the rated pressure. The closure of the water seat shall not be achieved by the use of the 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).

6.6 Nozzles shall have a rated pressure of not less than 12 bar (175 psi).

6.7 The minimum functional pressure of a nozzle shall not be greater than 66.7 percent of the minimum standby pressure intended for use with the nozzle.

6.8 For automatic nozzles incorporating a glass bulb heat responsive element, the filling end tip of the bulb shall be completely encased in an enclosure to minimize the potential for breakage or damage.

7 Protective Covers

7.1 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.

8 Strainer and Filter

8.1 A nozzle shall be provided with a strainer or filter constructed from corrosion resistant materials. The maximum dimension of an opening in the strainer or filter shall not exceed 80 percent of the smallest orifice diameter being protected.

Exception: This requirement does not apply to nozzles having water passages at least 5.3 mm (0.21 inch) in diameter.

PERFORMANCE

9 General

9.1 Water mist nozzles shall be tested for compliance with one or more of the Fire Tests described in Sections [40](#) – [47](#).

9.2 Unless other temperatures are indicated, tests are to be conducted at an ambient temperature of 20 ± 5 °C (68 ± 9 °F). Fire tests are to be conducted at an ambient temperature of 20 ± 10 °C (68 ± 18 °F). Fuel temperatures are to be 20 ± 10 °C (68 ± 18 °F).

9.3 Water mist nozzles normally supplied from a declining pressure or from a high pressure pump system are to be tested at their maximum rated pressure and at their minimum functional pressure, if applicable, as specified in the Manufacturer's Design and Installation Manual.

9.4 Water delivery delay times associated with water mist systems normally operating at standby pressures or those fitted with open nozzles shall be taken into account when conducting the fire performance tests described in Section [40](#) – [47](#).

10 Water Mist Nozzle Requirements

10.1 The tests in Sections [11](#) – [39](#) shall be conducted for each type of nozzle. Before testing, precise drawings of parts and the assembly shall be submitted together with the appropriate specifications and a copy of the manufacturer's design and installation instructions.

10.2 Nozzles shall be tested with all components required by their design and intended installation.

10.3 Before testing, nozzles shall be examined visually with respect to the following points:

- a) Marking;
- b) Conformity of the nozzles with the manufacturer's drawings and specifications; and
- c) Obvious defects.

11 Exposure Tests On Nozzles Incorporating Polymeric Gaskets

11.1 Nozzles with polymeric seals

11.1.1 A nozzle that incorporates a polymeric material to effect the closure of the orifice shall not leak when exposed to the pressures specified in [11.2](#) – [11.5](#), and shall operate at its minimum functional pressure after being exposed, in separate groups of samples, to the exposures specified in [11.2](#) – [11.5](#).

11.2 Corrosive exposures

11.2.1 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 [26.5.2](#), the second to hydrogen sulfide as specified in [26.4.2](#) and [26.4.3](#), and the third to carbon dioxide-sulfur dioxide as specified in [26.3.2](#) and [26.3.3](#). Each exposure period is to be 30 days.

11.2.2 Following the exposure, each nozzle is to be supplied with water at its minimum functional pressure. Each nozzle is then to be operated by exposing the heat responsive element to a uniform application of heat. The operating parts in contact with polymeric material of each test sample shall operate as intended within 5 seconds.

11.3 Temperature cycling exposure

11.3.1 Five samples are to be exposed to ten temperature cycles, each comprised of a 24-hour exposure to a low temperature of minus 40 °C (minus 40 °F) and a 24-hour exposure to a high temperature of 11 °C (20 °F) below its marked operating temperature or the test temperature in [Table 24.1](#), whichever is lower.

11.3.2 Following the exposures, each nozzle is to be supplied with water at its minimum functional pressure. Each nozzle is then to be operated by exposing the heat responsive element to a uniform application of heat. The operating parts in contact with polymeric material of each test sample shall operate as intended within 5 seconds.

11.4 Hydrocarbon exposure followed by moist air exposure

11.4.1 Two groups consisting of five samples are to be assembled. One group is to have the nozzle 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 nozzle inlet exposed to a solid mixture of saturated hydrocarbon chains ranging from C18 to C25, mixed in equal parts by weight. Sufficient hydrocarbon material is to be placed in the inlet to completely cover the polymeric seal. Both groups of nozzles are then to be conditioned at 21 ± 5.6 °C (70 ± 10 °F) 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 [26.7](#), with the nozzles installed in the pendent position and the hydrocarbon mixtures left in the inlet.

11.4.2 After these test exposures, each sample is to be pressurized to its minimum functional pressure 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.

11.5 Hydrocarbon exposure followed by water immersion exposure

11.5.1 Two groups, each consisting of five samples, are to be assembled and subjected to the hydrocarbon exposures described in [11.4](#). After the minimum 72 hour hydrocarbon exposure, the samples are to be hydrostatically pressurized to a pressure value of 1.7 bar (25 psig) less than the rated pressure for water mist nozzles having a rated pressure of less than 34.5 bar (500 psi) or the maximum standby pressure for nozzles having a rated pressure of 34.5 bar (500 psi) or greater 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 1.7 bar (25 psig) less than the rated pressure for water mist nozzles having a rated pressure of less than 34.5 bar (500 psi) or the maximum standby pressure for nozzles having a rated pressure of 34.5 bar (500 psi) or greater.

11.5.2 After these test exposures, each sample is to be pressurized to the minimum operating or standby pressure, examined for leakage for a period of 1 minute, and then operated by exposing the heat responsive element to a uniform application of heat.

12 Nominal Operating Temperatures

12.1 The nominal operating temperatures of automatic nozzles shall be as indicated in [Table 12.1](#).

Table 12.1
Nominal Operating Temperature Values

Glass bulb nozzles			Fusible element nozzles		
Nominal operating temp.		Liquid color code	Nominal operating temp.		Frame color code
°C	(°F)		°C	(°F)	
57	(135)	orange	57 – 77	(135 – 171)	uncolored
68	(155)	red	80 – 107	(176 – 225)	white
79	(175)	yellow	121 – 149	(250 – 300)	blue
93 – 107	(199 – 225)	green	163 – 191	(325 – 376)	red
121 – 141	(250 – 286)	blue			
163 – 182	(325 – 360)	mauve			

12.2 The nominal operating temperatures of automatic nozzles shall be specified in advance by the manufacturer and verified in accordance with [13.1](#).

12.3 The nominal operating temperature marked on the nozzle shall be that determined when the nozzle is tested in accordance with [13.2](#) and [13.4](#), taking into account the specifications of [13.1](#).

13 Operating Temperature Test

13.1 Automatic nozzles shall open within a temperature range of:

$$X \pm (0.035X + 0.62)^\circ C$$

$$[X \pm (0.035X)^\circ F]$$

in which:

X is the nominal operating temperature.

13.2 Ten nozzles are to be heated from ambient temperature to a test temperature 20 – 22 °C (36 – 40 °F) below their nominal operating temperature. The rate of increase of temperature is to not exceed 20 °C per minute (36 °F per minute) and the temperature is to be maintained for 10 minutes. The temperature is to then be increased at a rate between 0.4 – 0.7 °C (0.7 – 1.2 °F) per minute until the nozzle operates using equipment having an accuracy of 0.35 percent of the nominal rating or ±0.25 °C (±0.5 °F), whichever is greater.

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

13.4 The test is to be conducted in a water bath for nozzles having nominal operating temperatures less than or equal to 80 °C (176 °F). An oil having a flash point exceeding the test temperature is to be used for higher-rated operating elements. The liquid bath is to be constructed in such a way that the temperature deviation within the test zone does not exceed 0.5 percent, or 0.5 °C (0.9 °F), whichever is greater.

14 Discharge Coefficient Test

14.1 The flow constant K for nozzles is given by the formula:

$$K = \frac{Q}{P^{0.5}}$$

in which:

K is the nozzle flow constant;

Q is the flow rate in liters per minute (gallons per minute); and

P is the pressure in bar (pounds per square inch).

14.2 The value of K published in the manufacturer's design and installation instructions shall be verified using the test method specified in [14.3](#). The average flow constant K shall be within 10 percent of the manufacturer's published value.

14.3 The nozzle and a pressure gauge are to be mounted on a supply pipe. The pipe shall be sized so that the velocity head effect ($V^2/2g$) is reduced to approach a velocity of zero. The water flow is to be measured using a calibrated flow meter at pressures ranging from the minimum operating or standby pressure to the rated pressure at intervals of 10 percent of the operating range. In one series of tests, the pressure is to be increased from zero to each value and, in the next series, the pressure is to be decreased from the rated pressure to each value. During the test, pressures are to be corrected for differences in height between the gauge and the outlet orifice of the nozzle.

15 Water Distribution Test

15.1 The discharge characteristics of the nozzle shall be determined in accordance with [15.2](#) – [15.7](#).

15.2 Tests are to be conducted in a test chamber with minimum dimensions of 7 by 7 m (23 by 23 ft), or 300 percent of the maximum coverage area being tested, whichever is greater. A single open nozzle and four open nozzles arranged in a square at their maximum spacings are to be installed as specified in the manufacturer's design and installation instructions.

15.3 The distance between the ceiling and the distribution plate is to be 50 mm (2 inches) for upright nozzles and 275 mm (11 inches) for exposed pendent style nozzles or as specified in the manufacturer's design and installation instructions. For nozzles without distribution plates, the distances are to be measured from the ceiling to the outlet of the nozzle.

15.4 Recessed, flush, and concealed type nozzles are to be mounted in a false ceiling of dimensions not less than 6 by 6 m (20 by 20 ft) and arranged symmetrically in the test chamber. Nozzles are to be installed in the ceiling as specified in the manufacturer's design and installation instructions.

15.5 Arrange a sufficient number of 305 by 305 mm (1 by 1 ft) water collection pans on the floor in a square pattern to collect the water being discharged in one quadrant of the protection area referenced in the manufacturer's design and installation manual. Install a single nozzle in the vertical down position so that the distance between the top of the water collection pans and the horizontal plane of the nozzle outlet is 1 m (39.4 inches).

15.6 Discharge water at a flow rate corresponding to the minimum discharge pressure specified in the manufacturer's design and installation manual for at least 10 minutes and record the amount of water

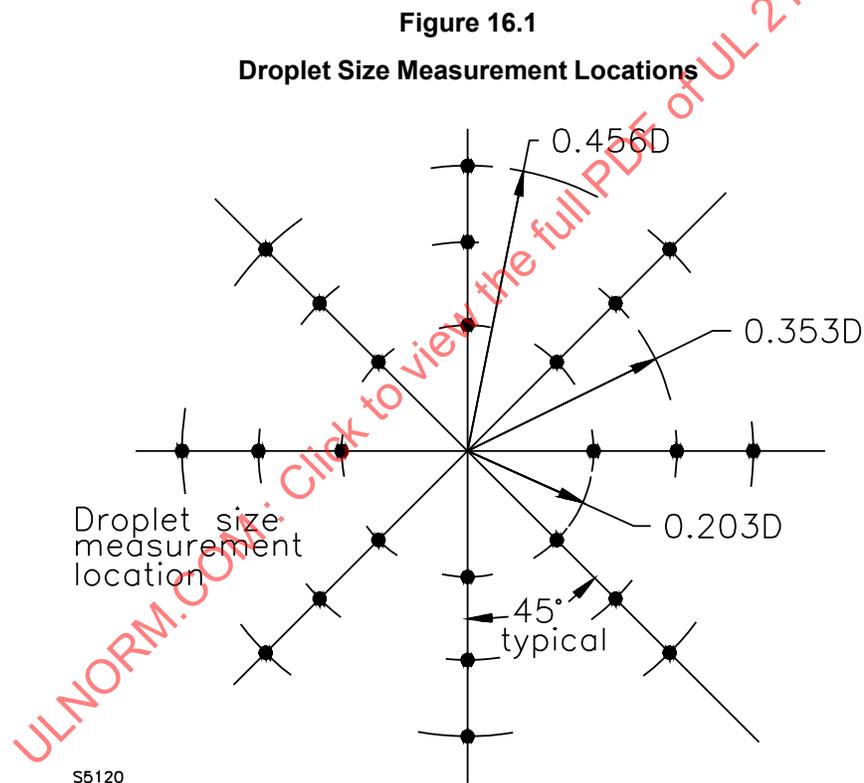
collected in each pan. Determine the smallest square pattern of water collection pans that contain at least 22.5 percent of the total water discharged. Twice the number of pans along a side of this square pattern is assumed to be the diameter, D , of the discharge pattern.

15.7 Repeat the same test procedure at a water flow rate corresponding to the maximum discharge pressure.

15.8 The results of the water distribution test are to be used to determine when additional fire tests are required as a result of changes in the discharge pattern over the operating pressure range.

16 Water Droplet Size and Velocity

16.1 The cumulative volumetric distribution of water droplets is to be determined in accordance with [16.2](#) – [16.5](#) and recorded as the flow rate per unit area weighted distribution of water droplets measured at the 24 locations shown in [Figure 16.1](#).



D is the diameter of the discharge pattern as determined in [15.6](#).

16.2 The radial array of measurement locations is to be positioned symmetrically about the central axis of the water mist nozzle. The nozzle spray patterns diameter D , utilized for calculating the radial distances to the measurement locations as determined in [15.6](#) at 1.0 m (39.4 inch) below the tip of the nozzle. Water discharge distribution measurements in a plane oriented perpendicular to the central axis of the nozzle and 1.0 m (39.4 inch) below the tip, are to be conducted using 0.305-m by 0.305-m (1-ft by 1-ft) collection pans centered on the radial measurement locations and oriented as shown in [Figure 16.1](#). In the case of spray pattern diameters less than 3.05 m (10 ft), multiple discharge tests are to be performed to avoid physical interference between the pans. Droplet size distribution measurements in a plane oriented perpendicular to the central axis of the nozzle and 1.0 m (39.4 inch) below the tip, are to be conducted at each of the 24 measurement locations shown in [Figure 16.1](#).