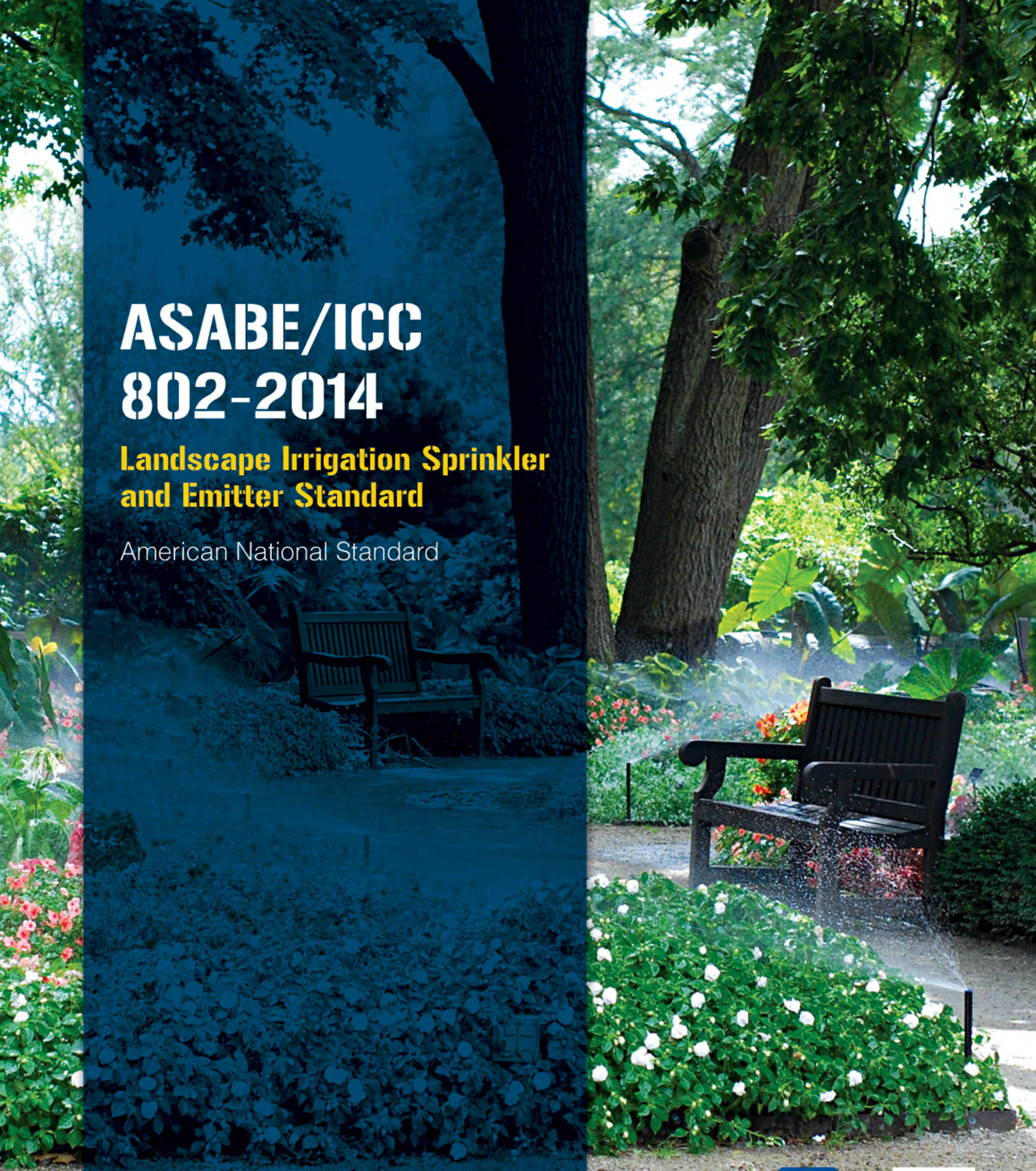
ASABE/ICC 802-2014

Landscape Irrigation Sprinkler and Emitter Standard

American National Standard



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Landscape Irrigation Sprinkler and Emitter Standard

American National Standard

International Code Council
500 New Jersey Avenue, NW, 6th Floor
Washington, D.C. 20001

Approved August 5, 2014

American National Standards Institute
1899 L Street, NW, 11th Floor
Washington, D.C. 20036

ASABE/ICC 802—2014 Landscape Irrigation Sprinkler and Emitter Standard
(ICC 802—2014)

First Printing: September 2014

ISBN: 978-1-60983-595-8

PRINTED IN THE U.S.A.

American National Standard

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FOREWORD

Introduction

In 2010, upon direction from the ICC Board of Directors, the ICC Standards Council appointed a consensus committee to develop a standard to cover the performance, design and testing of turfgrass and landscape irrigation sprinklers. In 2012, ICC and ASABE agreed to collaborate to develop the standard, dual-designating it as an ASABE/ICC standard. ASABE provided permission to incorporate material from several ASABE standards related to irrigation into the standard in order to coordinate the content of the standards.

Development

This is the first edition of the American Society of Agricultural and Biological Engineers (ASABE)/International Code Council® (ICC®) *Landscape Irrigation Sprinkler and Emitter Standard*. This standard was developed by the ICC Consensus Committee on Landscape Irrigation Emission Devices (IS-IEDC) that operates under ANSI-approved ICC Consensus Procedures for the development of ICC standards. Both ICC and ASABE are approved by ANSI as Accredited Standards Developers; however, this standard was developed under ICC's ANSI-approved Standard Development Procedures alone.

The meetings of the IS-IEDC Consensus Committee were open to the public and interested individuals and organizations from across the country participated. Views and objections were solicited through several public comment periods. All views and objections were considered by the consensus committee and an effort was made toward their resolution. A vote by the consensus committee approved this standard.

The technical content of currently published codes and documents on sprinklers was reviewed and considered by the committee. While there were many similarities among the practices and documents reviewed, there were marked philosophical differences that were considered by the committee. The requirements in ASABE/ICC 802—2014 are based on the intent to establish provisions consistent with the scope of the ICC family of codes and standards that adequately protect public health, safety and welfare; provisions that do not necessarily increase construction costs and provisions that do not unnecessarily restrict the use of new materials, technologies or designs.

Adoption

ASABE/ICC 802—2014, *Landscape Irrigation Sprinkler and Emission Standard* is available for reference and use by jurisdictions and codes internationally. Its use within a governmental jurisdiction is intended to be accomplished through adoption by reference in accordance with proceedings establishing the jurisdiction's law.

Interpretations

Requests for interpretations on the provisions of ASABE/ICC 802—2014 should be addressed to: ICC, Central Regional Office, 4051 Flossmoor Road, Country Club Hills, IL 60478.

Maintenance—Submittal of Proposals

All ICC standards are revised as required by ANSI. Proposals for revising this edition are welcome. Please visit the ICC website at www.iccsafe.org for the official "Call for Proposals" announcement. A proposal form and instructions can also be downloaded from www.iccsafe.org.

ICC, ASABE, its members and those participating in the development of ASABE/ICC 802—2014 do not accept any liability resulting from compliance or noncompliance with the provisions of ASABE/ICC 802—2014. Neither ICC nor ASABE have the power or authority to police or enforce compliance with the contents of this standard. Only the governmental body that enacts this standard into law has such authority.

International Code Council Consensus Committee on Landscape Irrigation Emission Devices (IS-IEDC)

Consensus Committee SCOPE: The Landscape Irrigation Emission Devices Standard Consensus Committee (IS-IEDC) shall have primary responsibility for minimum requirements to safeguard the public health, safety and general welfare along with product performance, design, durability and testing requirements for landscape irrigation emission devices. The requirements contained in the International Codes pertaining to these situations shall be coordinated with the standards developed by the IS-IEDC Consensus Committee.

This standard was processed and approved for submittal to ANSI by the ICC Consensus Committee on Landscape Irrigation Emission Devices (IS-IEDC). Committee approval of the standard does not necessarily imply that all committee members voted for its approval.

Representatives on the Consensus Committee are classified in one of three voting interest categories, General Interest (G), User Interest (U) and Producer Interest (P). The committee has been formed in order to achieve consensus as required by ANSI Essential Requirements. At the time it approved this standard, the IS-IEDC Consensus Committee consisted of the following members:

David Bracciano (P), Tampa Bay Water, Clearwater, Florida

Don Clark (P), Rain Bird Corporation, San Diego, California

Lorri Dennis (G), City of Carrollton, Carrollton, Texas

Michael Dukes, PhD (U), University of Florida, Institute of Food and Agricultural Sciences, Gainesville, Florida

Joanna Kind (G), U.S. Environmental Protection Agency - WaterSense Program, Santa Fe, New Mexico

Jeff Kremicki (P), Hunter Industries, San Marcos, California

Timothy Malooly (U), Water in Motion Inc., Plymouth, Minnesota

Brent Q. Mecham (P), Irrigation Association, Falls Church, Virginia

Lynn S. Niblock (G), Iredell County Inspections, Statesville, North Carolina

Julie Saare-Edmonds (G), State of California, Sacramento, California

Kent Sovocool (U), Alliance for Water Efficiency, Las Vegas, Nevada

Travis Tsunemori (U), American Society of Agricultural and Biological Engineers, St. Joseph, Michigan

Secretary: **Shawn Martin, Director** of PMG Activities, Plumbing, Mechanical and Fuel Gas Group, International Code Council, Pittsburgh, Pennsylvania

Voting Membership in Each Category

Category	Number
General (G)	4
User (U)	4
Producer (P)	4
TOTAL	12

Interest Categories

General Interest: Individuals assigned to the General Interest category are those who represent the interests of an entity, including an association of such entities, representing the general public, or entities that promulgate or enforce the provisions within the committee scope. These entities include consumers and government regulatory agencies.

User Interest: Individuals assigned to the User Interest category are those who represent the interests of an entity, including an association of such entities, which is subject to the provisions or voluntarily utilizes provisions within the committee scope. These entities include academia, applied research laboratory, building owner, design professional, government nonregulatory agency, insurance company, private inspection agency and product certification/evaluation agency.

Producer Interest: Individuals assigned to the Producer Interest category are those who represent the interests of an entity, including an association of such entities, which produces, installs or maintains a product, assembly or system subject to the provisions within the committee scope. These entities include builder, contractor, distributor, laborer, manufacturer, material association, standards promulgator, testing laboratory and utility.

NOTE—Multiple Interests: Individuals representing entities in more than one of the above interest categories, one of which is a Producer Interest, are assigned to the Producer Interest. Individuals representing entities in the General Interest and User Interest categories are assigned to the User Interest.

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SECTION 101
PURPOSE

101.1 Purpose. This standard is intended to establish minimum requirements for landscape irrigation emission devices to ensure adequate safety and performance, specify testing methods used to quantify product performance to enable component selection and specification in irrigation systems, and promote uniformity in classifying, rating and marking landscape irrigation emission devices.

SECTION 102
SCOPE

102.1 Scope. This standard shall apply to sprinklers and emitters intended to dispense water from landscape irrigation systems onto a landscape.

SECTION 103
APPLICABILITY

103.1 Applicability. This standard shall apply to sprinklers and emitters designed by the manufacturer for utilization within landscape irrigation systems. This standard shall not apply to sprinklers and emitters for use exclusively within agricultural irrigation systems or hose-end watering products or valve-in-head devices.

SECTION 104
CONVENTIONS

104.1 Conventions. Dimensions that are not stated as "maximum or minimum" are absolute. All dimensions are subject to conventional industry standards.

104.2 Units. Dimensions that are not stated shall be provided in inch/pound format with SI (metric) units provided in parentheses. References to gallons refer to U.S. gallons.

SECTION 105
REFERENCED DOCUMENTS

105.1 Reference documents. The codes and standards referenced in this standard shall be considered part of the requirements of this standard to the prescribed extent of each such reference. Chapter 5 contains a complete list of all referenced standards.

SECTION 106
MATERIALS

106.1 Materials. Landscape irrigation emission devices shall be resistant to UV degradation or oxidation without adversely impacting performance.

CHAPTER 2
DEFINITIONS

SECTION 201
GENERAL

201.1 General. For the purpose of this standard, the terms listed in this chapter have the indicated meaning.

201.2 Undefined terms. The meaning of terms not specifically defined in this document or in referenced standards shall have ordinarily accepted meanings such as the context implies.

201.3 Interchangeability. Words, terms and phrases used in the singular include the plural and the plural include the singular.

SECTION 202
DEFINED TERMS

ARC. Angular portion of a full circle covered by the discharge of a landscape irrigation spray, rotor, bubbler or emitter.

APPLICATION RATE. The rate at which water is applied to a given area by sprinkler(s) and emitter(s), usually expressed as depth per unit time (inches per hour or mm per hour). Also known as "Precipitation Rate."

COEFFICIENT OF VARIATION (CV). A measure of the variability of discharge of a random sample of a given make, model and size of microirrigation emitter, as produced by the manufacturer and before any field operation or aging has taken place; equal to the ratio of the standard deviation of the discharge of the emitters to the mean discharge of the emitters.

DISTANCE OF THROW. The distance measured from the sprinkler centerline to a point at which the sprinkler deposits water at the minimum rate required.

DISTRIBUTION PATTERN. A water depth-distance relationship measured from a single emission device.

DISTRIBUTION UNIFORMITY (DU). The measure of the uniformity of irrigation water applied to a defined landscape area.

Distribution uniformity of lower quarter (DULQ). The ratio of the average of the lowest one-fourth of measurements of irrigation water to the average of all measurements captured by collection devices, expressed as a dimensionless number with two decimal places.

EMISSION DEVICE. An irrigation system component that is used to dispense irrigation water to the landscape at a specific rate.

Sprinkler. An emission device consisting of a sprinkler body with one or more orifices to convert irrigation water pressure to high velocity water discharge through the air, discharging a minimum of 0.5 gallon per minute (1.9 liters per minute) at the largest area of coverage available for the nozzle series when operated at 30 psi (206.8 kPa) or more with a full-circle pattern.

Spray. A sprinkler that continuously applies water in a pattern to a defined landscape area.

Rotor. A sprinkler that applies water in a pattern by means of one or more rotating streams to a defined landscape area.

Bubbler. An emission device that floods the soil, discharging greater than 6.3 gallons per hour (24 liters per hour) when operated at 30 psi (206.8 kPa) and distributing water primarily through capillary action.

Microirrigation emission device. An emission device intended to discharge water in the form of drops or continuous flow at rates less than 30 gallons per hour (113.5 liters per hour) at the largest area of coverage available for the nozzle series when operated at 30 psi (206.8 kPa), except during flushing. Also known as "Low Volume Irrigation."

Drip emitter. A microirrigation emission device, with a flow rate less than or equal to 6.3 gallons per hour (24 liters per hour) when operated at 30 psi (206.8 kPa), designed to dissipate pressure and discharge a small uniform flow or trickle of water at a constant discharge rate.

Drip line emitter. A tube that discharges water from integrated evenly spaced emitters, perforations or a porous wall. Also known as "Line-Source Emitters" or "In-Line Emitters."

Multiple outlet emitter. A microirrigation emission device with more than one emission point from a centralized assembly.

Point-source emitter. A drip emitter that discharges water at a single emission point.

Microspray. A microirrigation emission device with one or more orifices to convert irrigation water pressure to water discharge with a flow rate not to exceed 30 gallons per hour (113.5 liters per hour) at the largest area of coverage available for the nozzle series when operated at 30 psi (206.8 kPa). Microsprays are inclusive of "microbubblers," "microspinners" and "microspray jets."

EMISSION POINT. The location where water is discharged from an emission device.

EMITTER EXPONENT. A numerical value that establishes the exponential relationship between the flow rate and inlet pressure of a drip emitter.

FILTER. Device used in micro- and sprinkler irrigation systems to remove debris from the water that might clog or otherwise foul emission devices.

HOSE-END WATERING PRODUCT. A temporarily positioned device that is used to dispense water to a landscape and is connected to a hose or pipe that is attached to a water supply system.

INTEGRAL CHECK VALVE. A self-acting component integral to an emission device designed to prevent water flow through an emission device up to a specified pressure when the emission device or group of sprinklers and emitters are not pressurized, usually expressed as "feet of elevation" or "feet of head."

LANDSCAPE. For the purposes of this standard, landscape refers to any and all areas that are planted or installed and intended to receive irrigation including, but not limited to, turfgrass, ground covers, shrubs, trees, flowers and similar plant materials as opposed to agricultural crops grown and harvested for monetary return.

LATERAL. A pipeline that supplies water from the valve to landscape irrigation emission devices.

NOMINAL FLOW RATE. The manufacturer's published flow rate data of a microirrigation emission device at the recommended operating pressure.

NOZZLE. The discharge opening or orifice of a sprinkler used to control the volume of discharge, distribution pattern and droplet size.

Multistream, multitrajectory (msmt) nozzles. Nozzles designed to distribute discharge water in a number of individual streams, of varying trajectories, which rotate across the distribution area.

NOZZLE ORIFICE. The emission point from a nozzle into the atmosphere.

OPERATING PRESSURE.

Maximum operating pressure. The highest manufacturer recommended pressure to ensure proper operation.

Minimum operating pressure. The lowest manufacturer recommended pressure to ensure proper operation.

Recommended operating pressure. The manufacturer's recommended pressure for operation of a sprinkler or emitter.

POP-UP STEM. A sprinkler component that elevates one or more nozzles a distance above grade when subjected to water pressure and retracts when water pressure is reduced.

PRECIPITATION RATE. See "Application Rate."

PRESSURE REGULATOR. A device that maintains constant downstream operating pressure immediately downstream from the device, which is lower than the upstream pressure.

RADIUS OF THROW. The distance of throw for a circular wetted pattern.

RISER. A pipe or tubing used to elevate an emission device above a lateral in an irrigation system.

SPRINKLER BODY. The exterior case or shell of a sprinkler incorporating a means of connection to the piping system, designed to convey water to a nozzle or orifice.

SPRINKLER HEAD. See "Sprinkler Body."

SPRINKLER IRRIGATION. A method of irrigation in which water is broadcast through the air to a defined area.

STRESS CRACK. An external or internal rupture in a plastic caused by tensile stresses less than its short-time mechanical strength.

Stress crack, environmental. A stress crack, the development of which has been accelerated by the environment to which the plastic is exposed, such as chemicals or elevated temperatures.

TRAJECTORY. The angle above the horizontal plane of the stream of water as it leaves an emission device.

TURF. The ground cover surface of mowed grass.

VALVE. A device used to control the flow of water within an irrigation system.

VALVE-IN-HEAD SPRINKLER. A sprinkler with an integral control valve intended to be operated from a remote location.

WETTED AREA. A wetted pattern created by one or more emission devices in a defined area (see "Radius of Throw" and "Distance of Throw").

SECTION 203
SYMBOLS

psi	=	Pounds per square inch
kPa	=	Kilopascals
gpm	=	Gallons per minute
gph	=	Gallons per hour
lpm	=	Liters per minute
ml/min	=	Milliliters per minute
mm/h	=	Millimeters per hour
ft	=	Feet
cm	=	Centimeters
mm	=	Millimeters
m	=	Meters
A	=	Area
AP	=	Pattern collection area
in/h	=	Inches per hour
ft/s	=	Feet per second
m/s	=	Meters per second
s_q	=	Standard deviation of flow rate
D	=	Deviation (%)
C_v	=	Coefficient of variation
AR	=	Application rate
Q	=	Volumetric flow rate
$\overline{Q}$	=	Mean volumetric flow rate
Q_n	=	Nominal volumetric flow rate

Q_{gpm}	=	Average flow rate (gallons per minute) for a given pressure.
DULQ	=	Lowest quarter distribution uniformity (unitless)
V_{LQ}	=	Volume of lowest quarter of samples
V_{avg}	=	Average volume
gal	=	Gallons
L	=	Liters
wt%	=	Weight percent
°F	=	Degrees Fahrenheit
°C	=	Degrees Celsius
N	=	Newtons

CHAPTER 3

GENERAL REQUIREMENTS FOR SPRINKLERS AND BUBBLERS

SECTION 301
GENERAL

301.1 General. Sprinklers and bubblers shall comply with the general requirements of this chapter.

SECTION 302
SPRINKLER AND BUBBLER DESIGN REQUIREMENTS

302.1 Rated temperature. Sprinklers and bubblers shall be designed to withstand ambient air temperatures from -40° to 140°F (-40° to 60°C) without permanent distortion or degradation of performance. Sprinklers and bubblers shall be operable at ambient air and water temperatures from 40° to 140°F (5° to 60°C) and dynamic water temperatures from 40° to 85°F (5° to 36°C) over the operating pressure range specified by the manufacturer.

302.2 Inlet connections. All inlet connections shall comply with the performance requirements of this standard. Where NPT pipe threads are used for inlet connections on sprinklers or bubblers, they shall be capable of mating with connections that comply with ASME B1.20.1 or ASTM F1498. All inlet connections shall comply with the performance requirements of this standard. All inlet connections shall be designed to withstand the full range of operating pressures without permanent distortion or leakage.

302.3 Filters and strainers. Where installed, filters and strainers shall consist of a cleanable or replaceable element or elements that can be accessed without removing the sprinkler or bubbler body from the system.

302.4 Servicing. Sprinklers or bubblers designed to allow the replacement of wearing or interchangeable parts shall be designed so that servicing can be accomplished without removing the body from the system.

302.5 Adjustments. Sprinklers or bubblers designed to allow the adjustment of any performance parameter shall be designed so that the adjustment can be accomplished while the device is installed.

302.6 Burst pressure. Sprinklers and bubblers shall withstand a hydrostatic test pressure of 1.5 times the maximum published operating pressure, but not less than 150 psi (1034 kPa), when tested in accordance with Section 303.5.1 without permanent distortion or leakage.

302.7 Check valve function. Sprinklers that are designed to have an integral means of preventing flow discharge through the emission device during periods of nonoperation shall be capable of preventing flow where the elevation change is equal to or less than 7 feet (3.0 psi).

302.8 Pressure regulation. Sprinklers intended for use with spray nozzles shall incorporate integral pressure regulation to deliver optimum spray nozzle performance as stated by the manufacturer.

SECTION 303
SPRINKLER AND BUBBLER PERFORMANCE REQUIREMENTS AND TEST METHODS

303.1 General. Sprinklers and bubblers subjected to testing shall comply with the test sample size, test conditions and order requirements in this section.

303.1.1 Samples. Unless otherwise specified in the test method, a minimum of five samples, selected at random from a lot of at least 25 units, shall be tested individually.

303.1.2 Conditioning. Test samples shall be conditioned (stored) at ambient laboratory conditions for a minimum of 12 hours prior to testing. Test samples shall be flushed prior to testing.

303.1.3 Installation. Test samples shall be installed in accordance with manufacturer's instructions and the procedures prescribed within each test.

303.1.4 Test conditions. Unless otherwise specified in the relevant test method, all tests shall be conducted at an ambient air temperature between 40° and 120°F (3° and 49°C) and the water supply temperature shall not exceed 78°F (25.5°C). The water supplies shall be filtered in accordance with the specifications of the manufacturer.

303.1.5 Order of tests. The tests required shall be conducted on a single set of test samples with burst pressure testing occurring last. Nothing shall prevent other tests from being conducted concurrently.

303.2 Spray devices tests and performance requirements. Spray devices shall be tested in accordance with the requirements in this section.

303.2.1 Required tests. Spray devices shall be tested in accordance with the test methods specified in Table 303.2.1. Tests for check valve function shall only be required where the associated function is incorporated into the spray device.

TABLE 303.2.1
SPRAY DEVICE TESTS

TEST NAME	SECTION
Flow rate	303.5.3
Distance of throw	303.5.4
Uniformity	303.6.2
Burst pressure	303.5.5
Pressure regulation	303.5.2
Check valve function[a]	303.5.1
Missing nozzle[b]	303.5.6

a. Testing required only where the spray devices incorporate integral check valve features.

b. Testing required only when the manufacturer's specifications indicate that there is a reduced flow when there is a missing nozzle.

303.2.2 Performance requirements. All spray device samples shall withstand a hydrostatic test pressure of 1.5 times the maximum operating pressure, but not less than 150 psi (1034 kPa), when tested in accordance with Section 303.5.1, without permanent distortion or leakage. Where an integral check valve function is incorporated into a spray device, a minimum of four out of five of the samples tested shall retain a minimum of 7 feet of head (3.0 psi), and no one sample shall retain less than 6.5 feet of head (2.8 psi) when tested in accordance with Section 303.5.1.

303.3 Rotor device tests and performance requirements. Rotor devices shall be tested in accordance with the requirements in this section.

303.3.1 Required tests. Rotor devices shall be tested in accordance with the test methods specified in Table 303.3.1. Tests for check valve function, pressure regulation and flow compensation shall only be required where the associated function is incorporated into the rotor device.

TABLE 303.3.1
ROTOR DEVICE TESTS

TEST NAME	SECTION
Flow rate	303.5.3
Distance of throw	303.5.4
Uniformity	303.6.2
Check valve function[a]	303.5.1
Pressure regulation[b]	303.5.2
Burst pressure	303.5.5

a. Testing required only where the rotor devices incorporate integral check valve features.

b. Testing required only where the rotor devices incorporate pressure regulation features.

303.3.2 Performance requirements. All rotor samples shall withstand a hydrostatic test pressure of 1.5 times the maximum operating pressure, but not less than 150 psi (1034 kPa), when tested in accordance with Section 303.5.1, without permanent distortion or leakage. Where an integral check valve function is incorporated into a rotor, a minimum of four out of five of the samples tested shall retain a minimum of 7 feet of head (3.0 psi), and no single sample shall retain less than 6.5 feet of head (2.8 psi) when tested in accordance with Section 303.5.1.

303.4 Bubbler device tests and performance requirements. Bubbler devices shall be tested in accordance with the requirements in this section.

303.4.1 Required tests. Bubbler devices shall be tested in accordance with the test methods specified in Table 303.4.1.

TABLE 303.4.1
BUBBLER DEVICE TESTS

TEST NAME	SECTION
Flow rate	303.5.3
Burst pressure	303.5.5

303.5 Test methods. Tests specified in Sections 303.2 through 303.4 shall be conducted in accordance with this section.

303.5.1 Check valve function test method. A head of water not less than 25 percent greater than the manufacturer's stated check valve head shall be connected to the inlet of the device with an integral check valve. The water column shall be permitted to drain until drainage ceases. The water column height shall be recorded after a period of 60 minutes.

303.5.2 Pressure regulator test method. Testing of spray devices with integral pressure regulators shall be conducted with a standard orifice, sized such that the flow is 1.5 +/- 0.1 gpm (5.7 +/- 0.4 lpm) at the manufacturer's stated regulation pressure. The test specimen shall be tested at inlet pressures between the regulation pressure and the maximum operating pressure. Specified test points shall be in 5 psi (34.5 kPa) increments up to 20 psi (137.9 kPa) above the stated regulation pressure and then in 10 psi (68.9 kPa) increments at even numbers of 10 psi to the maximum operating pressure. For test specimens with a maximum operating pressure not at an even number of 10 psi, the highest test point shall be the maximum operating pressure of the test specimen.

Prior to test initiation, inlet pressure shall be adjusted to within 1.0 psig (6.9 kPa) of the specified test point and stabilized. Stabilization is considered achieved when three consecutive pressure readings are within +/- 1 psi (+/- 6.9 kPa) of the specified test point.

Testing shall be conducted beginning with the lowest test point, and increase incrementally to the highest test point. Upon reaching the highest test point, the inlet pressure shall then be reduced incrementally to the lowest test point. Identical test points shall be used for both the increasing and decreasing pressure tests. At each test point, the pressure at the inlet and outlet of the test specimen shall be measured and recorded. Inlet pressure shall be measured at the inlet to the sprinkler body. Outlet pressures shall be measured downstream of the pressure regulation device but upstream of the orifice. Test specimens shall be supplied by straight, smooth piping that is free of fittings, except compliant pressure taps, for a minimum length of 20 times the inlet diameter of the nozzle test specimen. Supply piping shall be equal to or larger than the nominal inlet size of the test specimen. All pressure taps shall comply with ASME PTC 19.2. Inlet and outlet pressures shall be logged at no more than 30-second intervals and the test duration shall be a minimum of 3 minutes.

303.5.3 Flow rate test method. Each interchangeable nozzle designed for use with the sprinkler or each sprinkler with an integral nozzle and each bubbler shall be tested with no fewer than three pressure test points. Testing shall be conducted at the minimum, recommended and maximum operating pressures and shall be conducted beginning with the lowest pressure test point, and increasing incrementally to the highest pressure test point. Where nozzles are interchangeable between more than one spray body, testing of each nozzle on each spray body is not

required. Each interchangeable nozzle shall be tested on its designated rotor body or bodies.

303.5.3.1 Test apparatus. At each pressure test point, the flow rate and inlet pressure shall be measured and recorded. Test specimens shall be supplied by straight, smooth piping that is free of fittings, except compliant pressure taps, for a minimum length of 20 times the inlet diameter of the nozzle test specimen. Supply piping shall be equal to or larger than the nominal inlet size of the test specimen. All pressure taps shall comply with ASME PTC 19.2. Where flow metering devices are utilized, the flow shall be conditioned in accordance with manufacturer instructions and shall be installed in accordance with ASME PTC 19.5.

303.5.3.2 Volume over time method. Where flow rate is measured by means of a volume over time method, a minimum of 0.5 gallon (1.9 L) of discharge shall be collected or the test shall be run for a minimum of 1 minute, whichever results in the greater amount of discharge. Data shall be acquired and reported at no less than 1/100 of a gallon.

303.5.4 Distance of throw test method. Distance of throw testing shall be conducted in accordance with ASAE S398.1, except where otherwise specified in Sections 303.5.4.1 and 303.5.4.2. All patterns of coverage shall be evaluated in accordance with the test methods specified in ASAE S398.1 for radius of throw.

303.5.4.1 Procedure. Testing shall be conducted at the minimum recommended and maximum operating pressures. Each nozzle outlet shall be tested 4 inches (102 mm) above the rim of the collectors. Test specimens with a regular, symmetrical spray pattern shall be tested with collector spacing and grid type complying with Table 303.5.4.1. For circular pattern nozzle series, 90-, 180- and 360-degree patterns shall be tested. Test specimens with an asymmetrical, irregular spray pattern shall be tested using a rectangular grid with a maximum spacing of 1 foot (30.5 cm) between collectors, measured center to center. Variable radius devices shall be tested at the maximum radius setting for each test pressure.

Exception: Where a nozzle series does not contain a 90-, 180- or 360-degree nozzle, or the pattern is not circular, fixed spray testing shall be repeated for each series of nozzles with a minimum of three patterns.

TABLE 303.5.4.1
MAXIMUM COLLECTOR SPACING AND CATCHMENT ARRANGEMENT FOR REGULAR SPRAY PATTERNS

WATER DISTRIBUTION METHOD	MAXIMUM CENTER-TO-CENTER COLLECTOR SPACING (FEET)	CATCHMENT ARRANGEMENT
Spray pattern	1	Rectangular grid
Rotating stream(s)	2	Single leg

For SI:1 foot = 30.5 cm.

303.5.4.2 Data reduction. Distance of throw shall be determined in accordance with ASAE S398.1, Section 6. The average distance of throw for each pattern shall be reported individually.

303.5.5 Burst pressure test method. Test specimens shall be prepared with all nozzle outlets blocked and sealed. Each test specimen shall be filled with water and purged of all air prior to pressurization. Pressure is then to be applied at a rate not to exceed 300 psi per minute (2068 kPa per minute) and maintained for a minimum of 1 minute. Each test sample shall withstand a hydrostatic pressure of 1.5 times the maximum published operating pressure, but not less than 150 psi for 1 minute without permanent distortion or leakage exceeding 10 ml/min.

303.5.6 Missing nozzle test method. Five test specimens shall be tested and compared to a standardized riser assembly consisting of a standard orifice affixed to a pipe with $^1/_2$-inch nominal diameter Schedule 80 PVC. All test specimens shall be fitted with a standard orifice, sized such that the flow is 1.5 +/- 0.1 gpm (5.7 +/- 0.4 lpm) at the manufacturer's published optimal operating pressure.

No more than one test specimen shall be tested at a time and the inlet of all test specimens shall be located at the same position and orientation on the test stand. The outlet of the standard orifice on the test specimen shall be the same elevation as the outlet of the standardized riser assembly. Pressure measurement at the inlet to the sprinkler and flow rate measurement is required. Pressure and flow instrumentation shall be configured in accordance with the requirements of Section 303.5.3.1.

Testing shall be conducted at sprinkler inlet pressures (test pressures) equal to the manufacturer's published optimal operating pressure, and at 15 psig (103.4 kPa) and 30 psig (206.8 kPa) above the manufacturer's published optimal operating pressure for conditions with the standard orifice. The test shall commence by increasing the pressure to within +/- 1.0 psig (+/- 6.8 kPa) of the specified test pressure, stabilizing when three consecutive pressure readings are within +/- 1.0 psig (6.8 kPa) of the specified test pressure and then removing the standard orifices on the test specimen and the standardized riser assembly. With the standard orifice removed, a minimum of 10 seconds shall be allowed for flow stabilization, and then flow rate and inlet pressure shall be measured and recorded at a maximum of 10 second intervals for not less than 1 minute.

303.6 Calculation methods. Calculations specified in Sections 303.2 through 303.4 shall be conducted in accordance with this section.

303.6.1 Application rate calculation method. The theoretical application rate as a function of pressure for test specimens shall be calculated using the average flow rate. Average flow rate results at the minimum, recommended and maximum operating pressures from testing conducted according to Section 303.5.3 for each test specimen and nozzle combination shall be calculated using Equation 3-1. The average wetted pattern collection area shall be calculated using average distance of throw results from testing conducted according to Section 303.5.4 for the test specimen and nozzle combination.

$$ART = \frac{96.3 \times Q_{gpm}}{A_P} \quad \textbf{(Equation 3-1)}$$

where:

ART = Theoretical application rate (inches per hour for a given pressure).

Q_{gpm} = Average flow rate (gallons per minute) for a given pressure.

AP = Average pattern collection area (square feet) for a given pressure.

303.6.2 Uniformity modeling method. Uniformity shall be modeled using the data collected during the distance of throw test specified in Section 303.5.4 for the corresponding declared trajectory. Uniformity shall be modeled assuming a declared nozzle, distance of throw, arc, pressure, spacing type (rectangular/square, equilateral triangular) and spacing distance in accordance with Table 303.6.2. For all spacing types, the distance between heads along laterals shall be declared. Uniformity as modeled shall yield a value corresponding to the lowest quarter distribution uniformity (DULQ) for the set of volume or electronically recorded droplet measures obtained in Section 303.5.4:

$$\text{DULQ} = \frac{V_{LQ}}{V_{avg}} \quad \textbf{(Equation 3-2)}$$

where:

DULQ = Lowest quarter distribution uniformity (unitless).

V_{LQ} = Volume of average of lowest quarter of samples from the array of collectors used in Section 303.5.4 for determination of application rate.

V_{avg} = Average recorded volume as acquired from collectors in consistent units.

For all modeled uniformity measures, the modeled highest application rate and modeled lowest application rate shall be reported and the values measured for application in Section 303.5.4 shall fall within the range bounded by these values.

TABLE 303.6.2
REQUIRED DECLARATIONS OF SPACING

DECLARED SPACING TYPE	REQUIRED AND DECLARED SPACING VALUES
Rectangular/square	Average distance between heads Average distance between laterals
Equilateral triangular	Distance between heads Average distance between laterals
Triangular	Average distance between heads Average distance between laterals

SECTION 304
SPRINKLER AND BUBBLER PRODUCT MARKING

304.1 General. Sprinklers and bubblers shall be marked in accordance with Section 304.

304.1.1 Units. Dimensions shall be provided as prescribed in Section 304.2, 304.3 or 304.4. Marking with both the prescribed unit and the alternate SI or Imperial value in parentheses shall be permitted.

304.1.2 Location. Information required in Section 304 shall be made available to the end user, by a publicly available means. Examples of such means include, but are not limited to, the product, website, literature or packaging, unless otherwise specified.

304.1.3 Manufacturer name. The name or registered trademark of the manufacturer shall be provided for each sprinkler and bubbler. Where the product is manufactured for another organization for private labeling, the marking shall bear the name or trademark of the organization for which it was manufactured.

304.1.4 Connectors. Sprinklers and bubblers shall be provided with information indicating the nominal size and type of tubing or fittings appropriate for connection with the device.

304.1.5 Nozzle series marking. Nozzles shall be individually marked and shall have markings identifiable when the sprinkler is not in operation.

304.1.6 Instructions. Instructions for the installation, adjustment, operation and servicing of sprinklers and bubblers shall be provided on packaging, specification sheets, web pages, product catalogs or other publicly available means.

304.1.7 Check valve function. The presence of an integral check valve function shall be marked on sprinklers in a location visible after installation.

304.1.8 Pressure control features. The presence of integral pressure regulation or pressure compensation features designed to optimize nozzle performance shall be marked on sprinklers in a location visible after installation.

304.1.9 Integral flow shut-off. Differentiation shall be made between products with and without integral flow shut-off capabilities.

304.2 Marking of sprays and rotors. The following information shall be made available for sprays and rotors in addition to the applicable requirements in Section 304.1:

1. Design pop-up height in inches and the points of measurement used to establish the height.
2. Flow rate at the minimum, recommended and maximum operating pressure as measured in Section 303.5.3 in units of gallons per minute (gpm). Where the flow rate varies, depending on the nozzle or outlet selected, a range or table of flow rates shall be provided as an alternative.
3. Distance of throw at the minimum, recommended and maximum operating pressure as determined in Section 303.5.4 in units of feet (ft) for each nozzle or outlet. Where the distance of throw may vary, depending on the nozzle selected, a range or table of distances shall be provided as an alternative.
4. Spray pattern and the range of adjustability, as applicable.

5. Design trajectory angle in units of degrees.
6. Check valve head as determined in Section 303.5.1 in units of feet of water column.
7. Application rate at the minimum, recommended and maximum operating pressure as calculated in Section 303.6 in units of inches per hour (in/h). Where the application rate varies, depending on the nozzle selected, a range or table of application rates shall be provided as an alternative.
8. Regulation pressure as determined in Section 303.5.2 in units of pounds per square inch (psi).
9. Distribution uniformity of the lower quarter results for each nozzle as defined in Section 303.6.2 expressed as a range +/- 0.05 of the calculated DULQ.
10. Missing nozzle test results as defined in Section 303.5.6, expressed as an average flow change of all test specimens as a percentage of the standardized riser assembly at each test pressure.

Exceptions:

1. Where the sprinkler does not incorporate a check valve feature, the check valve feet or meters of head shall not be reported.
2. Reporting of missing nozzle test results required for sprays only when a manufacturer's specifications indicate that there is a reduced flow when there is a missing nozzle.

304.3 Marking of bubblers. If applicable, the following information shall be made available for bubblers in addition to the applicable requirements in Section 304.1:

1. Pop-up height in inches and the points of measurement used to establish the height.
2. Flow rate at the minimum, recommended and maximum operating pressure as measured in Section 303.5.3 in units of gallons per minute (gpm). Where the flow rate may vary, depending on the nozzle or outlet selected, a range or table of flow rates is acceptable.
3. Check valve head as determined in Section 303.5.1 in units of feet of water column.
4. Regulation pressure as determined in Section 303.5.2 in units of pounds per square inch (psi).

CHAPTER 4

REQUIREMENTS FOR MICROIRRIGATION EMITTERS AND MICROSPRAYS

SECTION 401 GENERAL

401.1 General. Microirrigation emitters and microsprays shall comply with the general requirements of this chapter.

SECTION 402 MICROIRRIGATION EMISSION DEVICE DESIGN REQUIREMENTS

402.1 Rated temperature. Microirrigation emitters and microsprays shall be designed to withstand ambient air temperatures from -40° to 140°F (-40° to 60°C) without permanent distortion or degradation of performance. Microirrigation emitters and microsprays shall be operable at ambient air temperatures from 40° to 140°F (5° to 60°C) and dynamic water temperatures from 40° to 85°F (5° to 36.4°C) over the operating pressure range specified by the manufacturer.

402.2 Tubing. Where microirrigation emission devices incorporate polyethylene pipe or tubing, that pipe or tubing shall comply with ASAE S435 or ISO 9261.

402.2.1 Dimensions and tolerances. Inside diameter, wall thickness and maximum outside diameter dimensions for polyethylene pipe or tubing incorporated into microirrigation devices shall be determined in accordance with ASAE S435 or ISO 9261.

402.2.2 Measurement of line-source emitter spacing. The spacing of emitters or perforations in line-source emitters shall be determined by means of measuring the distance between the geometric centers of each adjacent perforation or emitter outlet on five samples. Measurements shall be obtained with an accuracy of $+/-{}^{1}/_{16}$ inch (+/- 1.6 mm). Each sample shall include 20 measurements between consecutive emitters or perforations and shall not contain either the first or last emitter or perforation of the production lot. Test specimens shall not be extracted from adjacent sections of the pipe or tubing. The deviation of the average measured spacing of the emitter or perforations from the value declared by the manufacturer shall be less than 5 percent.

402.2.2.1 Reference temperature. Unless otherwise specified in ASAE S435 or ISO 9261, all dimensional measurements shall be carried out at an ambient air temperature of 73° ± 5°F (23° ± 3°C).

SECTION 403 MICROIRRIGATION EMISSION DEVICE PERFORMANCE REQUIREMENTS AND TEST METHODS

403.1 General. Microirrigation emission devices subjected to testing shall comply with the test sample size, test conditions and order requirements in this section.

403.1.1 Samples. Test samples shall comply with Sections 403.1.1.1 through 403.1.1.3, as applicable.

403.1.1.1 Point-source samples. Test samples shall include a minimum of 25 test specimens taken at random from a lot of at least 500 units, unless otherwise specified in the test method. For multiple outlet emitter devices, each outlet in each multiple outlet emitter device shall be tested.

403.1.1.2 Line-source samples. Test samples shall include a minimum of 25 test specimens taken at random with no more than five emission points per tubing coil, unless otherwise specified in the test method. Test specimens shall not be extracted from adjacent sections of the pipe or tubing. Line-source emitter test specimens shall not contain either the first or last emitter or perforation of the production lot.

403.1.1.3 Microspray samples. For flow-related testing (uniformity of flow rate, emitter flow rate as a function of inlet pressure, emitter exponent, deviation of mean flow rate from nominal flow rate, coefficient of variation, microspray flow rate), test samples shall include a minimum of 25 test specimens taken at random from a lot of at least 500 units, unless otherwise specified in the test method. For all other testing, a minimum of five test specimens taken at random from the 25 test specimens tested for flow rate shall be tested individually.

403.1.2 Conditioning. Test samples shall be allowed to condition at ambient laboratory conditions for a minimum of 12 hours prior to testing. Test samples shall be flushed prior to testing.

403.1.3 Installation. Test samples shall be installed in accordance with manufacturer's instructions and the procedures prescribed within each test.

403.1.4 Test conditions. Unless otherwise specified in the relevant test method, all tests shall be conducted at an ambient air temperature of 73° ± 5°F (23° ± 3°C) and a water supply temperature shall not exceed 78°F (25.5°C).

The water supplies shall be filtered in accordance with the specifications of the manufacturer.

403.1.5 Order of tests. Tests shall be conducted in the order specified in Section 403.2.

403.1.6 Accuracy of measuring devices. The accuracy of the measuring devices used shall comply with ISO 9261, Section 8.4.

403.2 Point-source drip emitter tests and performance requirements. Point-source drip emitters shall be tested in accordance with the requirements in this section.

403.2.1 Required tests. Regulated and unregulated point-source drip emitters shall be tested in accordance with the methods specified in Table 403.2.1.

TABLE 403.2.1
POINT-SOURCE DRIP EMITTER TESTS

TEST	SECTION
Uniformity of flow rate	403.5.1
Emitter flow rate as a function of inlet pressure	403.5.2
Emitter pull-out	403.5.5
Watertightness of the emitter-pipe assembly	403.5.6
Emitter exponent[a]	403.5.4
Check valve function[b]	303.5.1

a. Tests for emitter exponent shall only be required for pressure-compensating emitters.

b. Tests for check valve.

403.2.2 Performance requirements. Point-source drip emitters shall be in accordance with Table 403.2.2 as tested in Section 403.2.1. In-line emitter pull-out testing shall be conducted without any emitters disengaging from the test pipes. Testing of the watertightness of the emitter-pipe assembly shall be conducted without leakage at the emitter connection to the pipe or any location on the emitter, except the emission point.

TABLE 403.2.2
POINT-SOURCE DRIP EMITTER
PERFORMANCE REQUIREMENTS

PARAMETER	REQUIREMENT
Deviation of mean flow rate from nominal flow rate	±7% published pressure-flow data
Coefficient of variation	7% maximum
Flow rate as a function of inlet pressure	±7% published pressure-flow data
Emitter exponent[a]	0.2 maximum
Emitter pull-out force	9 pounds (40 N) minimum
Watertightness of the emitter-pipe assembly	No leakage at any location except emission point.

a. Tests for emitter exponent shall only be required for pressure-compensating emitters. Noncompensating emitters shall not be required to meet emitter exponent requirements in Table 403.2.2.

403.3 Line-source drip emitter tests and performance requirements. Line-source drip emitters shall be tested in accordance with the requirements in this section.

403.3.1 Required tests. Regulated and unregulated line-source drip emitters shall be tested in accordance with the test methods specified in Table 404.3.1.

TABLE 404.3.1
LINE-SOURCE DRIP EMITTER TESTS

TEST NAME	SECTION
Uniformity of flow rate	403.5.1
Emitter flow rate as a function of inlet pressure	403.5.2
Watertightness of the emitter-pipe assembly	403.5.6
Environmental stress crack resistance	403.5.7
Emitter exponent[a]	403.5.4
Check valve function[b]	303.5.1

a. Tests for emitter exponent shall only be required for pressure-compensating emitters.

b. Tests for check valve.

403.3.1.1 Line-source samples. Test samples shall include a minimum of 25 test specimens taken at random with no more than five emission points per tubing coil, unless otherwise specified in the test method. Test specimen shall not be extracted from adjacent sections of the pipe or tubing. Line-source emitter test specimens shall not contain either the first or last emitter or perforation of the production lot.

403.3.2 Performance requirements. Line-source drip emitters shall be in accordance with Table 403.3.2 as tested in Section 403.3.1.

TABLE 403.3.2
MAXIMUM LINE-SOURCE DRIP EMITTER
PERFORMANCE REQUIREMENTS

TEST NAME	REQUIREMENT
Deviation of mean flow rate from nominal flow rate	±7% published pressure-flow data
Coefficient of variation	7% maximum
Flow rate as a function of inlet pressure	±7% published pressure-flow data
Emitter exponent[a]	0.2 maximum
Watertightness of the emitter-pipe assembly	No leakage at any location except emission point.

a. Tests for emitter exponent shall only be required for pressure-compensating emitters.

403.4 Microspray tests and performance requirements. Microsprays shall be tested in accordance with the requirements in this section.

403.4.1 Required tests. Regulated and unregulated point-source microsprays shall be tested in accordance with the test methods specified in Table 403.4.1. Tests for check valve function shall only be required where a check valve is incorporated into the microspray. Tests for emitter exponents shall only be required for regulated microsprays.

TABLE 403.4.1
MICROSPRAY TESTS

TEST NAME	SECTION
Mircospray flow rate	403.5.3
Uniformity of flow rate	403.5.1
Microspray distance of throw	403.5.9
Check valve functions[a]	303.5.1

a. Tests for check valve function shall only be required where a check valve is incorporated into the emitter.

403.4.1.1 Microspray samples. For flow-related testing (uniformity of flow rate, emitter flow rate as a function of inlet pressure, emitter exponent, deviation of mean flow rate from nominal flow rate, coefficient of variation, microspray flow rate), test samples shall include a minimum of 25 test specimens taken at random from a lot of at least 500 units, unless otherwise specified in the test method. For all other testing, a minimum of five specimens taken at random from the 25 test specimens tested for flow rate shall be tested individually.

403.4.2 Performance requirements. Microsprays shall be in accordance with Table 403.2.2 as tested in Table 403.4.1. Pull-out testing shall be conducted without any microsprays disengaging from the test pipes.

TABLE 403.4.2
MAXIMUM MICROSPRAY PERFORMANCE REQUIREMENTS

TEST NAME	REQUIREMENT
Flow rate as a function of inlet pressure	±7% published pressure-flow data
Coefficient of variation	7% maximum
Deviation of mean flow rate from nominal flow rate	±7% published pressure-flow data

403.5 Test and calculation methods. Tests and calculations specified in Sections 403.2 through 403.4 shall be conducted in accordance with this section.

403.5.1 Uniformity of flow rate. Testing shall be conducted in accordance with ISO 9261, Section 9.1, except as specified in Section 403.5.1.1.

403.5.1.1 Conditioning. Regulated and unregulated test specimens shall be conditioned in accordance with ISO 9261, Section 9.1.3, except Section 9.1.3(h) shall be conducted as follows: Set the midpoint of the range of regulation and maintain it for 3 minutes.

403.5.1.2 Test procedure. Regulated and unregulated test specimens shall be tested in accordance with ISO 9261 Section 9.1.2. Each measured flow rate shall be reported in gallons per hour, and the operating pressure at which that flow rate was obtained. Using the flow rates obtained, the standard deviation of the flow rates, mean flow rates and the coefficient of variation shall be calculated in accordance with Equation 4-1. Deviation of mean flow rate from nominal flow rate shall be calculated in accordance with Equation 4-2.

$$C_v = \frac{S_q}{\overline{Q}} \times 100 \qquad \textbf{(Equation 4-1)}$$

where:

C_v = Coefficient of variation.

S = Standard deviation of the flow rates for the samples (gallons/hour).

$\overline{Q}$ = Mean flow rate of the sample (gallons/hour).

$$D = \frac{\overline{Q} - Q_n}{\overline{Q}} \times 100 \qquad \textbf{(Equation 4-2)}$$

where:

D = Deviation of mean flow rate from nominal flow rate (%).

$\overline{Q}$ = Mean flow rate of the sample (gallons/hour).

Q_n = Nominal flow rate (gallons/hour).

403.5.2 Emitter flow rate as a function of inlet pressure. Testing for flow rate as a function of inlet pressure shall be conducted in accordance with ISO 9261, Section 9.2, except that the emitter shall be tested at the recommended operating pressure in addition to the pressures specified in ISO 9261, Section 9.2.

403.5.3 Microspray flow rate test method. Where the microspray is designed to utilize interchangeable nozzles, the microspray shall be tested with each nozzle type, using 25 specimens taken from a random lot of at least 500 units. Where nozzles are interchangeable between more than one spray body, testing of each nozzle on each spray body shall not be required. Where microsprays incorporate an adjustable flow rate feature, testing shall be conducted at the maximum flow rate setting.

403.5.3.1 Procedure. Each test specimen shall be tested at no fewer than three pressure test points. Testing shall be conducted at the minimum, recommended and maximum operating pressures and shall be conducted beginning with the lowest pressure test point, and increasing incrementally to the highest pressure test point. At each pressure test point, the flow rate and inlet pressure shall be measured and recorded.

403.5.3.2 Test fixture. Test specimens shall be supplied by straight, smooth piping that is free of fittings, except compliant pressure taps, for a minimum length of 20 times the inlet diameter of the nozzle test specimen. Supply piping shall be equal to or larger than the nominal inlet size of the test specimen. All pressure taps shall comply with ASME PTC 19.2.

403.5.3.3 Flow measurement. Where flow metering devices are utilized, the flow shall be conditioned in accordance with manufacturer instructions and shall be installed in accordance with ASME PTC 19.5. Where flow rate is measured by means of a volume over time method, a minimum of 0.1 gallon (0.38 L) of discharge shall be collected or the test run for a minimum of 1 minute, whichever results in the greater amount of discharge.

403.5.3.4 Data reduction. Data shall be acquired and reported at no less than 1/100 of a gallon. Average flow rate and standard deviation of the sample population

shall be calculated and reported for each microspray or nozzle type, in the case of interchangeable nozzles.

403.5.4 Emitter exponent. The emitter exponent shall be calculated for regulated test specimens in accordance with ISO 9261, Section 9.3, using flow rate as a function of inlet pressure test results.

403.5.5 Emitter pull-out force. Testing for pull-out force shall be conducted using pipe suitable for use with the emitter, as specified by the manufacturer, in accordance with ISO 9261, Section 9.8.1.

403.5.6 Watertightness of the emitter-pipe assembly. Testing for watertightness of the emitter-pipe assembly shall be conducted using pipe suitable for the emitter, as specified by the manufacturer, in accordance with ISO 9261, Section 9.9. Emitters shall be installed on pipe for testing purposes using the tools and methods specified by the manufacturer.

403.5.7 Environmental stress-crack resistance. Testing for the resistance of polyethylene pipe utilized in line-source emitters shall be conducted in accordance with ASAE S435, Section 5.9.

403.5.8 Microspray distance of throw test method. Distance of throw testing shall be conducted in accordance with ASAE S398.1, except where specified in Sections 403.5.8.1 through 403.5.8.3. For circular pattern nozzle series, 90-, 180- and 360-degree patterns shall be tested in accordance with the methods specified. Variable radius devices shall be tested at the maximum radius setting for each test pressure.

403.5.8.1 Procedure. Each specimen shall be tested at no fewer than three pressure test points. Testing shall be conducted at the minimum, recommended and maximum operating pressures. Testing shall be conducted by initiating and maintaining flow through the microspray or nozzle at the test pressure. At the conclusion of the test, the amount of water in each collector shall be measured and recorded showing the location of the collectors relative to the microspray.

403.5.8.2 Test fixture. Test specimens shall be supplied by straight, smooth piping that is free of fittings, except compliant pressure taps, for a minimum length of 20 times the inlet diameter of the nozzle test specimen. Supply piping shall be equal to or larger than the nominal inlet size of the test specimen. The base pressure measurement location shall be defined as a point a distance of at least five times the nominal inlet diameter from the last upstream direction change or change in pipe cross-sectional area. All pressure taps shall comply with ASME PTC 19.2. Each nozzle microspray or outlet shall be mounted 9 inches (229 mm) above the rim of the nearest collectors. The microspray shall be mounted and remain vertical (+/- 2 degrees) throughout the duration of the test.

403.5.8.2.1 Collectors. Collectors shall be no greater than 25 square inches (161 square cm), measured on the outside of the collector, at the rim. The thickness of the rim of the collector shall be 0.125 inch (3 mm) or less. Each collector shall be touching the adjacent collector at the rim to a distance of 6 feet (1.8 m) from the test specimen. At distances greater than 6 feet (1.8 m) from the collector, the center-to-center spacing of the collectors shall be 6 inches (152 mm). All test collector rims shall be on the same plane with the same angular orientation. Collectors shall cover the wetted area of the test specimens, with the spacing specified, in all directions.

403.5.8.2.2 Wind measurement. Where testing is conducted outdoors, wind movement during the test shall be measured in accordance with ASABE S398.1, Section 4.4 and recorded. For outdoor and indoor testing, the average wind velocity shall be less than 4.4 feet per second (1.3 m/s). In no case during the measurement intervals shall wind velocity exceed 7.3 feet per second (2.2 m/s).

403.5.8.3 Data reduction. Distance of throw for individual samples shall be determined and calculated in accordance with Sections 403.5.8.3.1 and 403.5.8.3.2. Average distance of throw for each microspray or nozzle shall be calculated by averaging the result from each sample.

403.5.8.3.1 Distance measurement for circular wetted patterns. For circular wetted patterns, the radius of throw shall be determined by first identifying the farthest collector receiving water at a rate greater than 0.01 inch per hour (0.26 mm/h) in each angular direction. The distance from the centerline of the sprinkler to the centerline of each identified collector shall then be averaged. The radius of throw shall be the average distance value plus 1 foot (0.3 m).

403.5.8.3.2 Distance measurement for noncircular wetted patterns. For noncircular wetted patterns, multiple dimensions shall be provided to describe the size and shape of the wetted pattern. The distance of throw for a given dimension shall be determined by first identifying the farthest collector associated with that dimension receiving water at a rate greater than 0.01 inch per hour (0.26 mm/h). The distance from the centerline of the microspray to the centerline of each identified collector shall then be averaged. The distance of throw for each distance of throw dimension shall be the average distance value plus 1 foot (0.3 m).

SECTION 404
MICROIRRIGATION EMISSION DEVICE PRODUCT MARKING

404.1 General. Microirrigation emitters and microsprays shall be marked in accordance with Section 404.

404.1.1 Units. Dimensions shall be provided as prescribed in Section 404.2, 404.3 or 404.4. Marking with both the prescribed unit and the alternate SI or Imperial value in parentheses shall be permitted.

404.1.2 Location. All information required in Section 404 shall be made available to the end user, by a publicly available means. Examples of such means include, but are not limited to, the product, website, literature or packaging, unless otherwise specified.

404.1.3 Manufacturer name. The name or registered trademark of the manufacturer shall be provided for each microirrigation emission device. Where the product is manufactured for another organization for private labeling, the marking shall bear the name or trademark of the organization for which it was manufactured.

404.1.4 Inlet connectors. Microirrigation emission devices shall be provided with information indicating the size and type of tubing or fittings appropriate for connection with the inlet of the device.

404.1.5 Emitting pipe or tubing. Where microirrigation emission devices incorporate polyethylene pipe or tubing, the following information shall be provided:

1. The designation "emitting pipe" or "emitting tubing" followed by "ASAE S435" or "ISO 9261," as applicable, followed by the maximum working pressure (with units indicated).
2. Spacing of emitting units, where applicable. Units of spacing distance shall be indicated.

404.1.6 Instructions. Instructions for the installation, adjustment, operation and servicing of microirrigation emission devices shall be provided.

404.2 Microirrigation point-source drip emitter marking. The following information shall be made available for point-source drip emitters in addition to the applicable requirements in Section 404.1:

1. Minimum, recommended and maximum operating pressure in units of pounds per square inch (psi).
2. Flow rate at the recommended operating pressure as measured in Section 403.5.2 in units of gallons per hour (gph).
3. Flow rate coefficient of variation (C_v) and deviation of mean flow rate from nominal flow rate as a percentage as determined in Section 403.5.1.
4. Emitter exponent as determined in Section 403.5.4.
5. Check valve function as determined in Section 303.5.1. in units of inches of water column,

   Exceptions:

   1. Where the emitter does not incorporate a pressure-compensating feature, the emitter exponent shall not be provided.
   2. Where the emitter does not incorporate a check valve feature, the check valve head shall not be provided.

404.3 Microirrigation line-source drip emitter marking. The following information shall be made available for line-source drip emitters, in addition to the applicable requirements of Section 404.1:

1. Minimum, recommended and maximum operating pressure in units of pounds per square inch (psi).
2. Emitter flow rate at the recommended operating pressure as measured in Section 403.5.2 in units of gallons per hour (gph).
3. Flow rate coefficient of variation (C_v) and deviation of mean flow rate from nominal flow rate as a percentage as determined in Section 403.5.1.
4. Emitter exponent as determined in Section 403.5.4.
5. Check valve head as determined in Section 303.5.1 in units of inches of water column.
6. Emitter or perforation spacing as determined in Section 402.3.2 in units of inches.

   Exceptions:

   1. Where the emitter does not incorporate a pressure compensating feature, the emitter exponent shall not be provided.
   2. Where the emitter does not incorporate a check valve feature, the check valve head shall not be provided.

404.4 Microspray emitter marking. The following information shall be made available for microspray emitters, in addition to the applicable requirements of Section 404.1:

1. Minimum, recommended and maximum operating pressure in units of pounds per square inch (psi).
2. Flow rate at the recommended operating pressure as measured in Section 403.5.3 in units of gallons per hour (gph).
3. Flow rate coefficient of variation (C_v) and deviation of mean flow rate from nominal flow rate as a percentage as determined in Section 403.5.1.
4. Distance of throw at the recommended operating pressure as determined in Section 403.5.8 in units of feet (ft).
5. Spray pattern and the range of adjustability, as applicable.
6. Check valve head as determined in Section 303.5.1 in units of inches of water column.

   Exceptions:

   1. Where the emitter does not incorporate a pressure-compensating feature, the emitter exponent shall not be provided.
   2. Where the emitter does not incorporate a check valve feature, the check valve function shall not be provided.

CHAPTER 5

REFERENCED STANDARDS

This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title, and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in Section 105.

ASABE

American Society of Agricultural and Biological Engineers
2950 Niles Road
St. Joseph, MI 49085

Standard reference number	Title	Referenced in code section number
S398.1—1985 (R2012)	Procedure for Sprinkler Testing and Performance Reporting	303.5.4, 303.5.4.2, 403.5.8, 403.5.8.2.2
S435—1985 (R2009)	Polyethylene Pipe Used for Microirrigation Laterals	402.2, 402.2.1, 402.2.2.1, 403.5.7, 404.1.5

ASME

American Society of Mechanical Engineers
Three Park Avenue
New York, NY 100116-5990

Standard reference number	Title	Referenced in code section number
B1.20.1—83 (R2001)	Pipe Threads, General Purpose (Inch Series)	302.2
PTC 19.2—2010	Pressure Measurement	303.5.2, 303.5.3.1, 403.5.3.2, 403.5.3.3, 403.5.8.2
PTC 19.5—2004	Flow Measurement	303.5.3.1

ASTM

ASTM International
100 Bar Harbor Drive
West Conshohocken, PA 19428-2959

Standard reference number	Title	Referenced in code section number
F1498—08 (2012)e1	Standard Specification for Taper Pipe Threads 60° for Thermoplastic Pipe and Fittings	302.2

ISO

International Organization for Standardization
ISO Central Secretariat
1 ch, de la Voie-Creuse, Case Postale 56
CH-1211 Geneva 20, Switzerland

Standard reference number	Title	Referenced in code section number
9261—2004	Agricultural Irrigation Equipment – Emitters and Emitting Pipe – Specifications and Test Methods	402.2, 402.2.1, 402.2.2.1, 403.1.6, 403.5.1.1, 403.5.1.2, 403.5.2, 403.5.4, 403.5.5, 403.5.6