# WaterSense® Specification for Spray Sprinkler Bodies Supporting Statement

## I. Introduction

The U.S. Environmental Protection Agency's (EPA's) WaterSense program released its specification for spray sprinkler bodies with integral pressure regulation (sprinkler bodies) to further promote and enhance the market for water-efficient landscape irrigation products. Spray irrigation, which uses sprinklers that continuously apply water in a pattern to a defined landscape area[1], is a common type of irrigation used in residential and light commercial settings. The intent of the WaterSense specification is to help purchasers identify products that meet EPA's criteria for water efficiency and performance.

In-ground landscape irrigation sprinklers, which consist of a nozzle and a sprinkler body, are designed to operate within a range of pressures and have a recommended operating pressure under which the nozzle reaches its ideal performance. The sprinkler body, or the exterior shell that connects to the irrigation system piping and houses the nozzle, is the component that controls pressure at the inlet to the nozzle, which can affect the flow rate through the nozzle. Most sprinklers available on the market have an operating pressure range between 15 and 70 pounds per square inch (psi), with a recommended operating pressure of 30 psi. In many cases, sprinklers are installed at sites where the system pressure is higher than the recommended operating pressure. High operating pressure can result in system inefficiencies, including excessive flow rates, misting, fogging, and uneven coverage (e.g., dry spots or pooling water). Some sprinkler bodies have a built-in (i.e., integral) pressure-regulating feature that can compensate for high inlet pressure. These products can maintain and provide a constant flow at the nozzle across a range of inlet pressures, reducing excessive flows and water waste that would otherwise occur at high pressures. Additionally, when the sprinkler body maintains the pressure at or near its optimal operating pressure, the connected nozzle can generate the appropriate water droplet size and provide for more uniform distribution of water across the landscape.

To further reduce outdoor water waste and improve the performance and water efficiency of in-ground irrigation systems nationwide, EPA is adding spray sprinkler bodies to its suite of WaterSense labeled products. The average household using 50,500 gallons per year for outdoor water use with an irrigation system operating at 60 psi could save nearly 5,600 gallons of water per year by installing WaterSense labeled sprinkler bodies. Replacing all standard spray sprinkler bodies across the United States with WaterSense labeled models could save more than 31 billion gallons of water nationally each year.

## II. Current Status of Sprinkler Bodies

A 2005 survey estimated that 13.5 million in-ground irrigation systems were installed in residential landscapes across the United States[2]. Even though there are at least nine manufacturers that currently produce sprinkler bodies with integral pressure regulation, industry

[1] *ASABE/ICC 802-2014: Landscape Irrigation Sprinkler and Emitter Standard*
[2] U.S. Energy Information Administration. Residential Buildings Energy Consumption Survey, 2005.

estimates that less than 10 percent of irrigation systems installed in the United States include these products[3], leaving a large portion of the market available for transformation.

The American Society for Agricultural and Biological Engineers (ASABE) and the International Code Council (ICC) recently published the standard *ASABE/ICC 802-2014: Landscape Irrigation Sprinkler and Emitter Standard.* This standard provides design and performance requirements for landscape irrigation sprinklers, including a requirement for integral pressure regulation in sprinkler bodies. However, the standard is new to the industry and, to date, EPA is not aware of any sprinkler bodies that have been certified to meet the standard.

As mentioned above, most landscape irrigation sprinklers are optimized to operate at 30 to 45 psi. When installed in the field, sprinklers can be subject to much higher water supply pressures, which can affect system efficiency and performance. In developing this specification, WaterSense gathered available data from several water utilities and conservation organizations to understand the prevalence of high water pressure within irrigation systems. This information informed WaterSense's estimation of the water savings potential associated with labeling spray sprinkler bodies that have integral pressure regulation.

Specifically, WaterSense obtained irrigation system pressure data from two organizations. The first dataset was provided by the Utah State University Extension. This organization has been conducting a landscape irrigation system evaluation program since 1999. In this program, researchers visit homes and commercial, industrial, and institutional sites to evaluate outdoor irrigation systems. The second dataset was provided by the Center for Resource Conservation in Boulder, Colorado, which offers free onsite sprinkler consultations for residential properties. Trained irrigation auditors visit each property to conduct irrigation system inspections.

WaterSense combined these two datasets to analyze the percentage of systems with high pressure relative to the typical regulation pressure of a sprinkler body, which is around 30 psi for most products. Figure 1 shows the distribution of pressure measurements across the two datasets (the total number of records is more than 8,900). Approximately 63 percent of the systems operate at pressures above 30 psi. Approximately 50 percent of the systems operate at 40 psi and above, and approximately 20 percent operate at 60 psi and above. The distribution of irrigation system water pressures above 30 psi is significant and indicates the opportunity for water savings. Sprinkler bodies with integral pressure regulation typically begin to regulate pressure, and thus outlet flow, when the inlet pressure is above the regulation pressure. Therefore, the higher the inlet water pressure, the more significant the potential water savings.

[3] Communication with Brent Mecham, Irrigation Association. October 18, 2016.

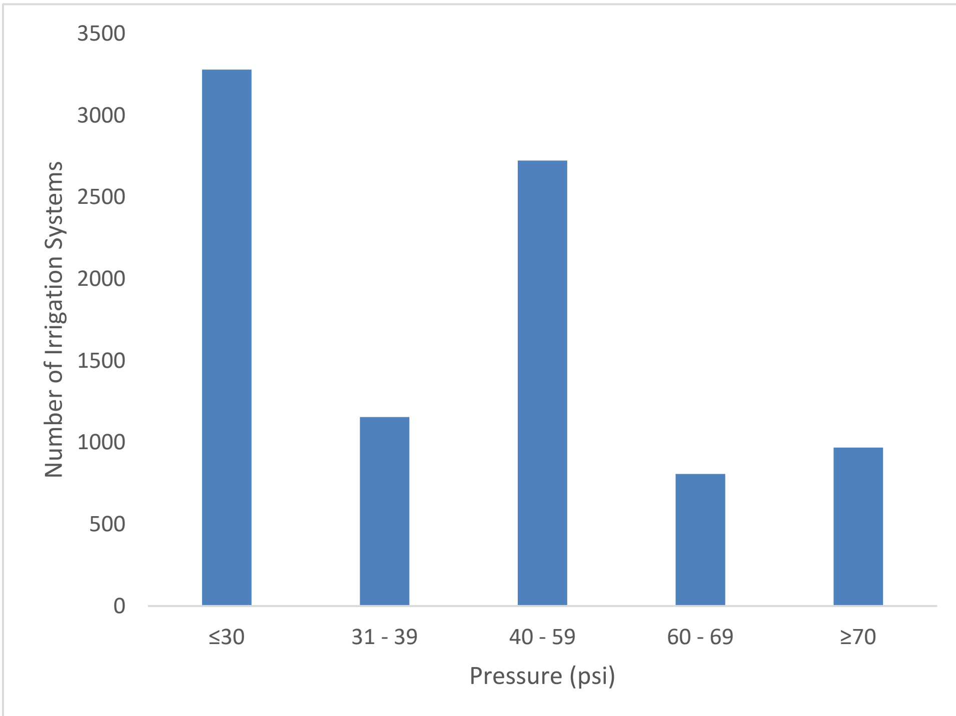


**Figure 1. Irrigation System Pressure Data, Utah State University and Center for Resource Conservation**

Though not specific to irrigation system operating pressure, the American Water Works Association Research Foundation published a table of water pressures in distribution systems for 15 cities across the United States and Canada in its 1999 *Residential End Uses of Water* study[4]. Pressures ranged from 20 psi to 500 psi (see Table 1). In many of the cities, the low end of the water pressure distribution range is greater than 30 psi.

**Table 1. Water Pressure Ranges in Distribution Systems**

| Utility/Provider | What are the range of pressures in your water distribution system? |
|---|---|
| Boulder, Colorado | 80 to 160 psi |
| Cambridge, Ontario | 20 to 100 psi |
| Waterloo, Ontario | 20 to 100 psi |
| Denver, Colorado | 40 to 110 psi |
| Eugene, Oregon | 40 to 80 psi |

[4] Mayer, Peter W. and William B. DeOreo. American Water Works Association Research Foundation. 1999. *Residential End Uses of Water*. Note that this table was not included in the updated *Residential End Uses of Water, Version 2* published in 2016.

**Table 1. Water Pressure Ranges in Distribution Systems**

| Utility/Provider | What are the range of pressures in your water distribution system? |
|---|---|
| Las Virgenes Municipal Water District (California) | 30 to 500 psi |
| Lompoc, California | 85 to 120 psi |
| Phoenix, Arizona | 60 to 120 psi |
| Municipal Region of Waterloo (Ontario) | 50 to 70 psi |
| San Diego, California | 40 to 85 psi |
| Scottsdale, Arizona | 40 to 120 psi |
| Seattle, Washington | 40 to 80 psi |
| Tampa, Florida | 20 to 65 psi (typical = 45 psi) |
| Tempe, Arizona | 50 to 90 psi |
| Walnut Valley Water District (California) | 40 to 180 psi |

Similarly, the National Resources Defense Council commissioned a study to examine utility system pressure from 246 utilities across Pennsylvania[5] and found median pressure to be 70 psi and the 90th percentile pressure to be approximately 106 psi. As with the data presented in Table 1, this dataset is not specific to irrigation system pressure, but indicates that the utilities in these areas deliver water to households at pressures well above 30 to 45 psi, the typical operating pressure of spray sprinkler bodies at which their performance is optimized.

The available data indicate that a large portion of irrigation systems could be operating at higher pressures than is recommended, which can waste water and result in other potential system inefficiencies. As described above, sprinkler bodies with integral pressure regulation are designed to maintain a constant outlet pressure and flow rate at the nozzle when supply pressure is above the recommended level. Depending upon the irrigation system operating pressure, this feature can result in significant water savings, from 10 to 20 percent or higher, as described in Section IV below.

WaterSense recognizes that the datasets, particularly related to irrigation system operating pressure, are limited to two locations, and they might not be fully representative of the range of irrigation system operating pressures across the United States. WaterSense requested additional irrigation system pressure data during the draft specification public comment period, but only received utility water system data, as referenced above in the Pennsylvania study.

[5] Kunkel Water Efficiency Consulting. 2017. *Report on the Evaluation of Water Audit Data for Pennsylvania Water Utilities*. https://www.nrdc.org/sites/default/files/pa-utilities-water-audit-data-evaluation-20170215.pdf.

## III. WaterSense Specification for Spray Sprinkler Bodies

### Scope

*ASABE/ICC 802-2014* defines a sprinkler as, "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 (gpm) (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." A sprinkler consists of two components, the sprinkler body and a nozzle.

Sprinklers can be classified into two types based on the way in which the water is applied to the landscape. A rotor sprinkler is defined as "a sprinkler that applies water in a pattern by means of one or more rotating streams to a defined landscape area"[6]. A spray sprinkler is defined as "a sprinkler that continuously applies water in a pattern to a defined landscape area"[7]. Spray sprinkler bodies are typically employed in irrigation systems installed in residential and light commercial settings.

With this specification, EPA is addressing the performance and efficiency of the body of a spray sprinkler. Specifically, it applies to spray sprinkler bodies with integral pressure regulation. EPA is defining this product category based on the definitions of the applicable components included in the *ASABE/ICC 802-2014*:

- 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.
- Pressure Regulator—Device that maintains constant downstream operating pressure immediately downstream from the device, given higher upstream pressure.

Spray sprinkler bodies with integral pressure regulation that have additional features (e.g., flow shutoff and/or check valves) are included in the scope of this specification, though at this point the specification only assesses the capability of the product to provide pressure regulation. For more information on products with these additional features, see the Flow Shutoff Feature and Associated Test Method discussion below.

This specification does not apply to the following products, based on the definitions in *ASABE/ICC 802-2014*. These products are constructed differently than spray sprinkler bodies and require different performance test methods and water efficiency and performance criteria:

- Nozzle[8]—Discharge opening or orifice of a sprinkler used to control the volume of discharge, distribution pattern, and droplet size.
- Rotor sprinkler body[9]—Body of a sprinkler that applies water in a pattern by means of one or more rotating streams to a defined landscape area.

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[6] ASABE/ICC 802-2014
[7] ASABE/ICC 802-2014
[8] See Appendix A of the *WaterSense Specification for Spray Sprinkler Bodies* for information on sprinkler bodies and nozzles that are sold together in the same package.
[9] Note that rotor sprinkler bodies house rotor nozzles. Multistream multitrajectory (msmt) nozzles, as defined in *ASABE/ICC 802-2014*, are "nozzles designed to distribute water in a number of individual streams, of varying trajectories, which rotate across the

- Bubbler—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 kilopascals (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."

Aftermarket (i.e., add-on) devices, or those products that are not sold with or integral to the sprinkler body, are also excluded because the intent of the specification is to recognize and label complete, fully functioning products that can provide the required efficiency and performance.

In providing consistency with *ASABE/ICC 802-2014*, this specification also does not apply to products for use exclusively within agricultural irrigation systems, hose-end watering products, or valve-in-head devices.

**Performance Test Method Development**

In July 2014, WaterSense published a Notice of Intent (NOI) to develop a draft specification for landscape irrigation sprinklers. WaterSense was initially considering a draft specification that would apply to both high-efficiency nozzles and pressure-regulating bodies (spray sprinkler bodies) of landscape irrigation sprinklers. However, based on public comment on the NOI and a lack of available data supporting water savings from high-efficiency nozzles, WaterSense decided to move forward with specification development for pressure-regulating sprinkler bodies only and suspend specification development for high-efficiency nozzles until data gaps were filled. For more information on this decision, please review *Landscape Irrigation Sprinklers: WaterSense Specification Update*, published in November 2015.

Related to sprinkler bodies, in the NOI WaterSense proposed to set a performance threshold for outlet pressure variance across a range of inlet pressures using the test method for pressure regulation outlined in *ASABE/ICC 802-2014.*[10] WaterSense suggested calculating savings based on the reduction in flow when pressure regulation is in place. WaterSense also indicated it would consider including specification criteria for sprinkler bodies that have the added ability to reduce flow when a nozzle is damaged or missing.

Based on public comments received in response to the NOI, WaterSense proceeded with specification development for sprinkler bodies. In early 2015, WaterSense developed a draft method for performance testing that was primarily based on *ASABE/ICC 802-2014*, Section 303.5.2 (pressure regulator test method), with several modifications. First, NOI commenters suggested that WaterSense evaluate pressure regulation at both a low and a high flow rate. The *ASABE/ICC 802-2014* standard only requires testing at one flow rate (1.5 gpm), so WaterSense incorporated additional testing at a high flow rate (3.5 gpm). Second, stakeholders requested WaterSense measure the outlet flow rate as well as outlet pressure, so WaterSense

distribution area." These are not classified as "rotor sprinkler nozzles," but as spray sprinkler nozzles and the bodies that house msmt nozzles are included in the scope of this specification.

[10] *ASABE/ICC 802-2014* was in draft format at the time of the NOI, but the methodology regarding testing pressure regulation did not change from draft to final.

incorporated an outlet flow rate measurement. *ASABE/ICC 802-2014* specified approximately 12 pressure levels moving up and down a pressure curve (e.g., 30 psi up to 70 psi in increments of 10 psi, and then back down to 30 psi in increments of 10 psi). However, WaterSense reduced the number of levels to five (10 psi above the regulation pressure; 60 psi; 70 psi or the maximum operating pressure, whichever is greater; 60 psi; and 10 psi above the regulation pressure). This change was aimed to decrease the time and burden required for performance testing, while still allowing for each product to be tested across a range of pressures.

Using the modified draft test method, WaterSense worked with three independent laboratories to determine if the test method was repeatable and reproducible. As part of their initial review of the test method, the laboratories noted that the standard orifice required by *ASABE/ICC 802-2014* to control flow was onerous and unnecessary. As a result, testing was conducted using a variety of other flow control devices, such as a needle valve or variable arc nozzle.

From April 2015 to April 2016, each laboratory tested three models of three separate brands of spray sprinkler bodies with integral pressure regulation, as well as three models of standard spray sprinkler bodies of the same brands. Results from the performance testing demonstrated that the spray sprinkler bodies with integral pressure regulation were able to effectively regulate pressure and flow rate. However, the results were inconsistent among laboratories, indicating the test method needed to be calibrated and clarified. WaterSense subsequently revised the test method to specify that a needle valve should be used to control flow. Note that the use of the needle valve requires the fabrication and use of an adapter to connect the needle valve to the sprinkler body, as described in Appendix B of the specification. Additionally, WaterSense revised the method to introduce a reduction to 0 psi between each tested pressure level, to address hysteresis found in initial results. For additional information on the independent laboratory performance testing and subsequent test method revisions, please review *Landscape Irrigation Sprinklers: WaterSense Specification Update*, published in November 2015.

In fall 2016, WaterSense worked with the University of Florida Department of Agricultural and Biological Engineering to conduct a final round of performance testing on eight spray sprinkler body models with integral pressure regulation and three standard spray sprinkler body models using the revised test method. WaterSense requested this additional testing to further validate and refine the test protocol, determine the range of product performance, and evaluate potential savings of spray sprinkler bodies with integral pressure regulation when compared to their standard counterparts (e.g., standard spray sprinkler bodies). The data from the University of Florida performance testing form the basis for the efficiency and performance criteria included in the specification, as well as the water savings estimates described in Section IV of this supporting statement.

Based on the results from the University of Florida testing, WaterSense made two additional changes to the test method, resulting in the version included in Appendix B of the specification for spray sprinkler bodies. First, WaterSense eliminated testing at the nominal flow rate of 3.5 gpm. The University of Florida data showed, across the range of products tested, that the ability to regulate pressure at flow rates of 1.5 gpm and 3.5 gpm was very similar and that the higher flow rate did not result in more variability in the performance of the product. WaterSense chose to retain testing only at 1.5 gpm because this is the flow rate specified in *ASABE/ICC 802-2014,* and it is the flow rate more commonly found in the field. In addition, eliminating the high flow rate test further streamlines and reduces the burden and cost of the test.

In addition, WaterSense eliminated the last two pressure test levels on the downward limb of the pressure curve (i.e., the second 60 psi test and second test at 10 psi above the regulated pressure), resulting in only three tested pressure levels (10 psi above the regulated pressure, 60 psi, and 70 psi, or the maximum operating pressure, whichever is greater). The University of Florida data suggest that the results from testing on the rising limb of the pressure curve and decreasing limb of the pressure curve were similar, indicating only one set of these pressure levels is needed. In addition, from a practical standpoint, sprinklers in the field are not operated up and down a range of pressures in a short period of time, as the *ASABE/ICC 802-2014* test method requires. Thus, WaterSense has determined that testing at three increasing pressure levels (low, medium, and high) is sufficient in order to determine the ability of the products to adequately compensate across a range of pressures and provide consistent flow.

**Water Efficiency and Performance Criteria**

Based on the University of Florida data, WaterSense selected water efficiency and performance criteria based on both flow rate and outlet pressure. Performance related to flow rate ensures water savings are realized when installed in an irrigation system with high pressure. While WaterSense has a goal of promoting flow reduction by using these products, EPA is also setting a performance criterion to ensure the irrigation system functionality is not impacted. Low pressure can impact the uniformity of the water applied across the landscape. By including a performance criterion to ensure pressure drop through the sprinkler body is not too low, sprinkler bodies with nozzles functioning in the field should be able to perform adequately.

The subsections below further explain the flow rate and performance requirements outlined in the specification. To ensure that the requirements address potential product variability, the specification requires testing of five samples of each product, as specified in ASABE/ICC 802-2014, Section 303.1.1.

*Flow Rate Requirements*

To comply with EPA's water efficiency requirements, the product must meet two flow requirements:

- Maximum flow rate at any tested pressure level—The percent difference between the initial calibration flow rate (as described in Appendix B of the specification) and the maximum flow rate at any tested pressure level, averaged for the selected samples at the test pressure levels where the maximum flow rate occurred, shall not exceed +/- 12.0 percent.

- Average flow rate across all tested pressures—The percent difference between the initial calibration flow rate (as described in Appendix B of the specification) and the flow rate at each tested pressure level, averaged across all pressure levels and all selected samples shall not exceed +/- 10.0 percent.

The percent difference between the initial calibration flow rate, which is 1.5 gpm +/- 0.1 gpm when evaluated at the regulation pressure for the product as specified by the manufacturer (30 psi for most products), and the flow rate at the tested pressure levels (e.g., 40.0, 60.0, 70.0 psi), indicates how well the sprinkler body regulates flow at the given test pressure. Products with lower percentage differences are able to maintain flow rates at or near 1.5 gpm across a range of operating pressures.

WaterSense included flow rate requirements at the maximum flow rate at any tested pressure and across all tested pressures. This ensures products perform at the high end of pressures found in the field, as well as intermediate pressures within the operating range of the sprinkler body. WaterSense selected +/- 12.0 percent difference from the maximum flow rate at any tested pressure and +/- 10.0 percent difference in flow rate at all tested pressure levels, based on the performance testing conducted at the University of Florida and stakeholder comments received during the draft specification public comment period. The majority of the sprinkler bodies with integral pressure regulation performed at these levels or better (Figure 2).

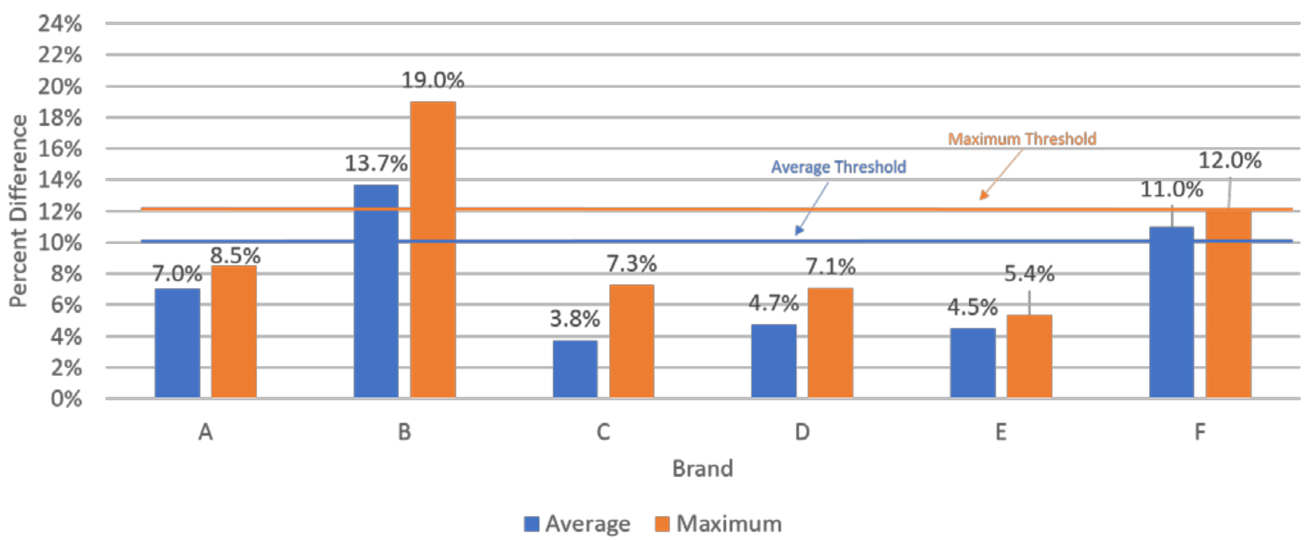


**Figure 2. Percent Difference Between Flow Rate at Tested Pressure Level(s) and the Flow Rate at the Calibration Point**

*Outlet Pressure Requirement*

The specification for spray sprinkler bodies requires that the average outlet pressure at the initial calibration point not be less than two-thirds (67 percent) of the regulation pressure.

WaterSense selected a minimum outlet pressure of two-thirds (67 percent) of the regulation pressure at the calibration point to prevent a pressure drop across the sprinkler body significant enough to impact performance. This criterion is stated as a minimum outlet pressure relative to the regulation pressure to ensure that products with higher regulation pressures (e.g., 45 psi) meet minimum pressure requirements generally associated with these products for proper function in the field (e.g., they are commonly used with multi-stream multi-trajectory nozzles that require a minimum pressure to rotate properly).

*Flow Shutoff Feature and Associated Test Method*

Though not addressed in this specification, WaterSense is interested in evaluating and potentially including specification criteria at some point in the future for sprinkler bodies that have a flow shutoff feature that can significantly reduce or completely stop the flow when the nozzle is damaged or missing. This commonly occurs when a mower damages or completely severs the nozzle from the sprinkler body, among other causes. Although flow shutoff is an important water saving feature, WaterSense is currently only aware of two products on the market that include this technology. Requiring a flow shut-off feature at this point would significantly limit the potential impact and availability of WaterSense labeled sprinkler bodies. WaterSense would like to see the market develop more in this arena before requiring this feature. In the future, should the market develop, WaterSense will reconsider the addition of this feature. However, WaterSense expects some water savings will be realized when a nozzle is damaged or missing from the pressure regulation feature alone.

## General Sprinkler Body Requirements

In addition to meeting water efficiency and performance requirements, the specification requires conformance with Section 302 of *ASABE/ICC 802-2014,* which addresses general design and health and safety requirements for sprinklers (and bubblers). This section establishes criteria related to elements such as rated temperature, inlet connections, filters and strainers, servicing, adjustments, burst pressure, check valve function, and pressure regulation. EPA has determined that these requirements are essential for preserving the long-term efficiency and performance of WaterSense labeled sprinkler bodies. EPA expects that many sprinkler bodies currently on the market already incorporate features that meet these requirements. WaterSense does not anticipate that manufacturers will have technical difficulties in complying with these criteria.

## Product Marking Requirements

The specification requires conformance with all applicable subsections of Section 304.1 of *ASABE/ICC 802-2014,* which describe the general product marking requirements for sprinklers (and bubblers). The requirements aim to ensure that end users are aware of product features that are essential for product selection and proper design of an irrigation system. The requirements designate how to convey certain product information such as dimension units, location where the marking information should be conveyed, manufacturer name, size and type of connectors, installation, operation and maintenance instructions, location of the check valve function, presence of pressure control features, and availability of integral flow shutoff. EPA has determined that these requirements are essential for helping the purchasers choose the appropriate product for their application and will help to preserve the long-term efficiency and performance of WaterSense labeled sprinkler bodies.

Additionally, the specification requires the product and/or its associated packaging or documentation identify the regulation pressure and maximum operating pressure. WaterSense added this requirement to those already in *ASABE/ICC 802-2014* so its licensed certifying bodies can identify the regulation and maximum operating pressures for testing purposes, ensuring these products perform across the range of advertised operating pressures.

## IV. Potential Savings and Cost-Effectiveness

Appendix A provides the assumptions and calculations used to derive these estimates.

### Potential Water Savings

Spray sprinkler bodies with integral pressure regulation have the potential to save significant amounts of water. WaterSense assumes that 90 percent of the 13.5 million irrigation systems installed in the United States are candidates for replacement. Since the exact proportion of spray versus other irrigation application methods is not known, EPA is assuming half of all outdoor water use is used for spray irrigation for the purpose of this estimate. EPA estimates that the average household using 50,500 gallons per year for outdoor water use could save nearly 5,600 gallons of water per year by installing WaterSense labeled sprinkler bodies. Nationally, WaterSense estimates that installing labeled products in systems that operate at water pressures greater than 30 psi could save more than 31 billion gallons of water and $345 million in water supply and wastewater costs annually.

### Cost-Effectiveness

Spray sprinkler bodies with integral pressure regulation are marginally more expensive than standard spray sprinkler bodies, costing approximately $80 more to install in an average sized landscape that requires 25 sprinkler heads for irrigation. Replacing existing sprinkler bodies with labeled models could save more than $60 annually for the average irrigation system, with a payback period of 2.1 years. However, if labeled products are being installed in a new irrigation system or as part of natural replacement of existing sprinkler bodies, the payback period for covering the marginal cost difference between these products and standard spray irrigation bodies would be 1.3 years.

## V. Certification and Labeling

EPA has established an independent, third-party product certification process, described in the *WaterSense Product Certification System*. Under this process, products are certified to conform to applicable WaterSense specifications by accredited licensed certifying bodies. Manufacturers are authorized by licensed certifying bodies to use the WaterSense label in conjunction with labeled products.

While it is uncommon that sprinkler bodies and nozzles are sold in the same package, EPA has provided guidance in Appendix A of the specification on how to address this packaging combination. If this occurs, the packaging must bear the WaterSense label. The packaging must clearly indicate which component within the package has been certified to bear the label and display its associated model number.

# Appendix A: Calculations and Key Assumptions

## Potential Water Savings Calculations

Assumptions:

- Fifty percent of outdoor water is used for spray irrigation[11].
- Ninety percent of the 13.5 million irrigation systems[12] are candidates for installation of spray sprinkler bodies with integral pressure regulation[13].
- Average outdoor water use per household is 50,500 gallons per year[14].
- Systems that operate at 60 psi can realize 22 percent water savings by installing a spray sprinkler body with integral pressure regulation[15]. This assumption is used when calculating average household water savings from installing labeled models.
- Percentage of irrigation systems that operate within certain water pressure ranges and estimated savings from installing labeled models at various pressure ranges, which are needed to estimate national water savings, are listed in Table A1.
- The cost of water for irrigation is $11.02 per 1,000 gallons[16]. This rate includes the costs of both water supply and wastewater treatment. It is possible, although uncommon, that a homeowner could be billed separately for these utility service connections and would only incur the water supply costs for water used for irrigation.

**Table A1. Distribution of Irrigation Systems and Anticipated Water Savings within Water Pressure Ranges**

| Irrigation System Water Pressure Range (psi) | Percentage of Irrigation Systems within Pressure Range[17] | Percentage Water Savings from Installing WaterSense Labeled Sprinkler Bodies in Irrigation System[18] |
|---|---|---|
| ≤30 | 36.7 | 0 |
| 31 to 39 | 12.9 | 5 |
| 40 to 59 | 30.5 | 16 |
| 60 to 69 | 9.0 | 23 |
| ≥70 | 10.9 | 24 |

[11] Personal communication with Brent Mecham, Irrigation Association. October 18, 2016.
[12] Residential Energy Consumption Survey, 2005. Although this survey is dated, it represents the best national dataset available on prevalence of irrigation systems.
[13] Personal communication with Brent Mecham, Irrigation Association. October 18, 2016.
[14] Water Research Foundation. DeOreo, William B., Peter W. Mayer, B. Deziegielwski and J, Kiefer. Residential End Uses of Water, Version 2. 2016. Table 6.32, Page 154.
[15] University of Florida. 2016. Performance Testing of Pressure Regulating Sprinkler Bodies. Study conducted by Michael Dukes, P.E., Ph.D. Department of Agricultural and Biological Engineering.
[16] Raftelis Financial Consulting. Water and Wastewater Rate Survey. American Water Works Association. 2016.
[17] Based on composite landscape evaluation/audit data from the Center for Resource Conservation in Boulder, Colorado, and Utah State University.
[18] Based on savings estimates between standard spray sprinkler bodies and spray sprinkler bodies with integral pressure regulation across the range of tested pressure levels. University of Florida Department of Agricultural and Biological Engineering. 2016. Performance Testing of Spray Sprinkler Bodies. Study conducted by Michael Dukes, P.E., Ph.D.

*Equation 1. Average Annual Irrigation Water Savings From Installing WaterSense Labeled Sprinkler Bodies*
(50,500 gallons/year) x (50 percent spray irrigation use factor) x (22 percent savings factor) = 5,555 gallons/household/year

*Equation 2. Candidates for Installation of Labeled Models*
(13,500,000 irrigation systems) x (90 percent candidates for installation) = 12,150,000 irrigation systems

*Equation 3. Annual National Water Savings From Installing WaterSense Labeled Sprinkler Bodies* = [(12,150,000 candidate irrigation systems) x percent of systems within a water pressure range (from Table A1)] x [(50,500 gallons/year outdoor water use) x (50 percent spray irrigation use factor) x percentage water savings from installing labeled models in systems within a water pressure range (from Table A1)] = See Table A2.

**Table A2. Annual National Water Savings From Installing WaterSense Labeled Sprinkler Bodies**

| Irrigation System Water Pressure Range (psi) | Annual Water Savings (gallons) |
|---|---|
| ≤30 | 0 |
| 31 to 39 | 1.98 billion |
| 40 to 59 | 14.96 billion |
| 60 to 69 | 6.37 billion |
| ≥70 | 7.99 billion |
| **Total** | **31.3 billion** |

*Equation 4. Annual National Cost Savings From Installing WaterSense Labeled Sprinkler Bodies*
(31.3 billion gallons/year) x ($11.02/1,000 gallons) = $345,000,000

### Cost-Effectiveness Calculations

Assumptions:

- Useful life of the sprinkler body is 5 years based on information from five manufacturers.
- The average cost of an individual pressure-regulating sprinkler body is $5.12, as estimated from vendor information[19].
- The average cost of a standard sprinkler body is $1.84, as estimated from vendor information[20].
- Average household landscape area is 5,826 square feet[21].
- Half of the average landscaped area is spray irrigated[22].

[19] Based on cost information for pressure-regulating sprinkler bodies provided by SiteOne Landscape Supply on August, 4 2016.
[20] Based on cost information for standard sprinkler bodies provided by SiteOne Landscape Supply on August, 4 2016.
[21] Water Research Foundation. DeOreo, William B., Peter W. Mayer, B. Deziegielwski and J, Kiefer. Residential End Uses of Water, Version 2. 2016. Table 6.31, Page 151.
[22] Personal communication with Brent Mecham, Irrigation Association. October 18, 2016.

- Assumes four sprinklers are required for head-to-head coverage at square spacing.
- Assumes 50 percent of sprinklers are 12-foot radius, and 50 percent are 15-foot radius. The majority of the spray sprinklers installed are 12-foot and 15-foot quarter and half circle sprinklers[23].
- An adjustment factor of 1.5 was used to account for overlap of sprinklers in a continuous pattern and to account for additional sprinklers required in real-world irregular shapes.

*Equation 5. Annual Water Cost Savings from Installing WaterSense Labeled Sprinkler Bodies on a Spray Irrigation System*

(5,555 gallons/system/year) x ($11.02/1,000 gallons) = $61/system/year

*Equation 6. Average Spray Irrigated Area*

(5,826 square feet landscape area) x (50 percent) = 2,913 square feet

*Equation 7. Number of 12-Foot Radius Sprinklers for the Average Spray Irrigated Area*

[(2,913 square feet) x (50 percent)] ÷ (12 feet x 12 feet) = 10.1 12ft radius spray sprinklers

*Equation 8. Number of 15-Foot Radius Sprinklers for the Average Spray Irrigated Area*

[(2,913 square feet) x (50 percent)] ÷ (15 feet x 15 feet) = 6.5 15ft radius spray sprinklers

*Equation 9. Total Number of Spray Sprinklers Installed for the Average Spray Irrigated Area*

(10.1 spray sprinklers + 6.5 spray sprinklers) x (1.5 real world factor) = 25 spray sprinklers

*Equation 10. Estimated Payback Period for the Marginal Cost Difference Between Spray Sprinkler Bodies With Integral Pressure Regulation and Standard Models (i.e., installing labeled models in a new irrigation system)*

[($5.12 - $1.84) x (25 sprinkler bodies/irrigation system)] ÷ ($61/year) = 1.3 years

*Equation 11. Estimated Payback Period for the Average Cost of Replacing Standard Sprinkler Bodies in an Existing System With Labeled Models at the End of Their Useful Life*

[($5.12/sprinkler body) x (25 sprinkler bodies/irrigation system)] ÷ ($61/year) = 2.1 years

[23] Personal communication with Michael Dukes, P.E., Ph.D. University of Florida. October 18, 2016.