

WaterSense® High-Efficiency Lavatory Faucet Specification

Supporting Statement

I. Introduction

The WaterSense program released its High-Efficiency Lavatory¹ Faucet Specification (specification) on October 1, 2007, to promote and enhance the market for water-efficient lavatory faucets. The goal of this specification is to allow consumers to identify and differentiate products in the marketplace that meet this specification's criteria for water efficiency and performance.

This specification addresses lavatory faucets and lavatory faucet accessories² in private use, such as those found in residences, and private restrooms in hotels and hospitals. Since these types of faucets are used primarily for hand washing and other sanitary activities, such as face washing and razor rinsing, WaterSense believes that maximum flow rates can be reduced enough to impact national water consumption while at the same time not negatively impacting user satisfaction. This specification is not intended to address kitchen faucets, which have a very different set of uses and performance criteria, or public restroom faucets (e.g., airports, theaters, arenas, stadiums, offices, and restaurants), which already have national performance standards and criteria to which they should conform.

II. Current Status of Faucets

WaterSense estimates that currently there are 222 million residential lavatory faucets in the United States. This estimate is based on an assumed one-to-one ratio of lavatory faucets to residential bathrooms.³ In addition to the existing stock, approximately 25 million new faucets are sold each year for installation in new homes or replacement of aging fixtures in existing homes.⁴ Of these 25 million faucets, roughly two-thirds of those are lavatory faucets (approximately 17 million units). Residential lavatory and kitchen faucets account for

¹ Lavatory is the terminology used in the Energy Policy Act of 1992 and ASME A112.18.1 to describe the types of faucets to which the standards apply. In this specification, lavatory means any bathroom sink faucets intended for private use.

² Accessory, as defined in ASME 112.18.1, means a component that can, at the discretion of the user, be readily added, removed, or replaced, and that, when removed, will not prevent the fitting from fulfilling its primary function. For the purpose of this specification, an accessory can include, but is not limited to lavatory faucet flow restrictors, flow regulators, aerator devices, laminar devices, and pressure compensating devices.

³ U.S. Census Bureau, American Housing Surveys for the United States, 1970-2003.

⁴ Business Trend Analysts, 2006. "2005/2006 Outlook for the U.S. Plumbing Fixtures and Fittings Industry." <www.mindbranch.com/catalog/print_product_page.jsp?code=R225-358>

approximately 15.7 percent of indoor residential water use in the United States⁵—equivalent to more than 1.1 trillion gallons of water used each year.

The Energy Policy Act of 1992 originally set the maximum flow rate for both lavatory and kitchen faucets at 2.5 gallons per minute (gpm) at 80 pounds per square inch (psi) static pressure. In 1994, American Society of Mechanical Engineers (ASME) A112.18.1M-1994–Plumbing Supply Fittings set the maximum flow rate for lavatory faucets at 2.2 gpm at 60 psi. In response to industry requests for conformity with a single standard, in 1998, the U.S. Department of Energy adopted the 2.2 gpm at 60 psi maximum flow rate standard for all faucets (see 63 FR 13307; March 18, 1998). This national standard is codified in the *U.S. Code of Federal Regulations* at 10 *CFR* Part 430.32. As a point of reference, the maximum flow rates of many of the pre-1992 faucets range from 3 to 7 gpm. Other than the aforementioned maximum flow rate standards, there currently are no universally accepted performance tests or specifications (e.g., rinsing or wetting performance standards) for faucets.

III. WaterSense High-Efficiency Lavatory Faucet Specification

Scope

The WaterSense program developed this specification to address criteria for improvement and recognition of water-efficient and high-performance lavatory faucets and lavatory faucet accessories. WaterSense labeled lavatory faucet accessories can be incorporated into the design of new faucets to control the flow rate and provide the mechanism for meeting this specification's criteria, or can be purchased separately and retrofit onto existing older faucets to provide water efficiency and performance. This specification focuses solely on the category of lavatory faucets intended for private use because of the differences in the uses and performance expectations between private lavatory faucets and kitchen or public restroom faucets. Lavatory faucets are used primarily for hand washing and other sanitary activities, such as teeth brushing, face washing, and shaving. For these activities, discussions with faucet manufacturers and water utility representatives provided a general consensus that a reduction in the maximum flow rate from 2.2 gpm (the current federal water-efficiency standard) to 1.5 gpm, as established by this specification, is not very noticeable for most users. The most noticeable differences are increased wait times when filling the basin or waiting for hot water. While decreasing a faucet's maximum flow rate increases user wait time for these activities, WaterSense determined the potential water savings gained from the primary use of lavatory faucets (i.e., washing and rinsing) outweigh any potential inconvenience caused by increased wait times and will not negatively impact overall user satisfaction.

Kitchen sink faucets were excluded from this specification because the different uses and user expectations require other considerations for defining performance. One major performance consideration is a kitchen faucet's ability to effectively rinse dishes. Kitchen faucets also are commonly used for pot or container filling, and significantly increased wait times might not be acceptable to most users. WaterSense determined that reducing the maximum flow rates of kitchen faucets would create issues of user satisfaction and be counter to its program goals of

⁵ Mayer, Peter W. and William B. DeOreo. Residential End Uses of Water. Aquacraft, Inc. Water Engineering and Management. American Water Works Association. 1998.

increasing efficiency while maintaining or improving performance. In order to maintain user satisfaction and ensure a high level of performance, a maximum flow rate greater than what is suitable for lavatory faucets might need to be considered for kitchen faucets. Some type of wetting or rinsing performance test also might need to be included. In addition, there is an emerging area of research and development in multiposition control lever faucet technologies that offer users “high” and “low” settings for different activities. While performance data are not yet available, these technologies might prove to be effective in using water more efficiently. For these reasons, WaterSense intends to evaluate the possibility of developing a WaterSense specification for kitchen faucets at a later date.

Public restroom and metering faucets (faucets that are set to discharge a specific amount of water or run for a specified period of time for each use) also were excluded from this specification because of their differing uses and performance expectations and because standards governing their maximum flow rate already exist. Public restroom faucets, for example, are used almost exclusively for hand washing or simple rinsing, compared to lavatory faucets in homes and in other private bathrooms that face a myriad of uses. As a consequence, the maximum flow rate for these public restroom and metering fixtures can be set significantly lower than the flow rate for private lavatory faucets without negatively impacting user satisfaction. Also, a separate set of standards already apply to these types of fixtures. Codified in the *U.S. Code of Federal Regulations* at 10 *CFR* Part 430 (specifically §430.32(o) Faucets) are standards setting the maximum flow rate for metering faucets at 0.25 gallons/cycle. Section 5.4.1 and Table 1 of ASME A112.18.1/CSA B125.1–Plumbing Supply Fittings also establish the maximum flow rates for public lavatory (other than metering) faucets at 0.5 gpm. As a consequence, this category of faucet is not covered by the current specification. If WaterSense decides to address water efficiency and performance for these types of faucets, it will do so under a separate specification at a later time.

Water-Efficiency and Performance Criteria

The water-efficiency component of this specification establishes a maximum flow rate of 1.5 gpm at an inlet pressure of 60 psi. Lowering the maximum flow rate from 2.2 gpm to 1.5 gpm (both at 60 psi) represents a 32 percent reduction, which is consistent with WaterSense’s stated goal of improving efficiency by at least 20 percent. Even when installed in systems with high water pressure (up to 80 psi), faucets designed to this specification will have maximum flow rates of approximately 1.75 gpm, which still represents a greater than 20 percent increase in efficiency. WaterSense chose to specify a test pressure of 60 psi to maintain consistency with the current industry standard (ASME A112.18.1–Plumbing Supply Fittings) to which all faucets sold in the United States must comply.

The requirements of this specification are also in harmony with other international standards. The Joint Standards Australia/Standards New Zealand Committee established standards for the rating and labeling of water-efficient products (AS/NZS 6400:2005). As part of the standard, water-efficient faucets are rated on a scale of 1 to 6 based on maximum flow rates. Under this system, comparable 1.5 gpm WaterSense labeled lavatory faucets would receive a 5 out of 6 star rating, meeting criteria for maximum flow rates between 4.5 liters per minute (L/min) (1.2 gpm) and 6.0 L/min (1.6 gpm).

Meeting or exceeding user expectations via the establishment of performance criteria for WaterSense labeled products is an important aspect of the WaterSense program. From the outset of discussions with interested parties, WaterSense was aware that performance of water-efficient lavatory faucets is affected by low water pressures. To ensure user satisfaction with WaterSense labeled lavatory faucets or lavatory faucet accessories across a range of possible user conditions, WaterSense has established a minimum flow rate of 0.8 gpm at 20 psi in the specification.

In developing these water-efficiency and performance criteria, WaterSense evaluated comments received during the draft specification's public forum and public comment period (see *Response to Issues Raised During Public Comment on February 2007 Draft Specification for WaterSenseSM Labeling of High-Efficiency Lavatory Faucets*). WaterSense also considered user satisfaction data generated from four high-efficiency lavatory faucet retrofit studies and the impact of pressure changes on product flow rates for various types of lavatory faucet accessories.

WaterSense established a maximum flow rate of 1.5 gpm at 60 psi because interested parties that provided comments on the draft specification generally agreed that a flow rate of 1.5 gpm would provide no noticeable difference for most users. In addition, data collected from retrofit studies demonstrate a high level of user satisfaction with high-efficiency lavatory faucets that have maximum flow rates of 1.0 and 1.5 gpm. Aquacraft, Inc. conducted retrofit studies in Seattle, Washington (2000)⁶ and East Bay Municipal Utility District (EBMUD), California (2003)⁷ in which they replaced existing lavatory faucet aerators with 1.5 gpm pressure compensating aerators. In the Seattle study, 58 percent of the participants felt their faucets with the new aerators performed the same or better than their old faucet fixtures and 50 percent stated they would recommend these aerators to others. In the EBMUD study, 80 percent of the participants felt their faucets with the new aerators performed the same or better than their old faucet fixtures, and 67 percent stated they would recommend these aerators to others. A third Aquacraft, Inc. retrofit study conducted in Tampa, Florida (2004)⁸ replaced existing lavatory faucet aerators with 1.0 gpm pressure compensating aerators. The participants in this study were receptive to an even higher-efficiency fixture, with 89 percent saying their new aerators performed the same or better than their old faucet fixtures and would recommend them to others. Seattle Public Utilities also provided WaterSense with survey results of customer use and satisfaction with 1.0 gpm pressure compensating aerators distributed through the utility's direct-mail showerhead and faucet aerator pilot program. According to its survey, 94 percent of the participants that received the free aerators installed them and only 2 percent disliked the aerators and removed them.⁹

⁶ Seattle Home Water Conservation Study: The Impacts of High-Efficiency Plumbing Fixture Retrofits in Single-Family Homes, December 2000.

⁷ Water Conservation Study: Evaluation of High-Efficiency Indoor Plumbing Fixture Retrofits in Single-Family Homes in the East Bay Municipal Utility District Service Area, July 2003.

⁸ Tampa Water Department Residential Water Conservation Study: The Impacts of High-Efficiency Plumbing Fixture Retrofits in Single-Family Homes, January 2004.

⁹ Seattle Public Utilities. "Showerhead/Aerator Pilot Program Summary." Unpublished.

WaterSense established a minimum flow rate of 0.8 gpm at 20 psi for several reasons. First, WaterSense felt this minimum flow rate was reasonable to ensure user satisfaction in homes with low water pressure based on comments that were received regarding the draft specification. Second, WaterSense received comments from several utilities regarding programs in which 1.0 gpm lavatory faucet aerators are provided to customers. These products have shown a high level of user satisfaction, and WaterSense wants to recognize these products and the efforts of the utilities to ensure that additional water savings can be achieved through such programs. Third, WaterSense wants to avoid restricting design options to the extent possible. The specification leaves open the possibility for the use of fixed orifice flow control devices (with a maximum flow rate of 1.5 gpm) instead of restricting manufacturers to the use of pressure compensating devices. Under the specification, a 1.5 gpm maximum flow rate fixed orifice aerator could qualify for use of the label (according to currently available product specifications and flow curves). Pressure compensating devices with maximum flow rates between 1.5 and 1.0 gpm could also qualify for the use of the WaterSense label (according to currently available product specifications and flow curves). WaterSense believes that this approach allows for the greatest degree of design freedom for manufacturers and supports existing utility programs, while still ensuring a high level of performance and user satisfaction.

In order for high-efficiency lavatory faucets to effectively emerge in the market following the release of the final version of this specification, the market must ideally be equipped to produce the faucets or faucet technology that the specification requires. WaterSense is not currently aware of any lavatory faucets on the market with a maximum flow rate of 1.5 gpm. There are, however, several types and models of faucet components and accessories currently available that have the capability to control the flow to the level that is required by this specification. As a result, WaterSense is confident that faucets and faucet accessories that meet the requirements of this specification can be readily brought to market.

Potential Water and Energy Savings

To estimate water and energy savings that can be achieved by products that meet this specification, WaterSense examined the Seattle (2000) and EBMUD (2003) Aquacraft retrofit studies, which provided actual water consumption reductions generated by the installation of high-efficiency, pressure-compensating 1.5 gpm aerators on lavatory faucets. WaterSense expects the results under this specification to be similar to what was found in these two studies. These studies indicate that installing high-efficiency aerators can yield significant reductions in household water consumption. Post faucet retrofit, the weighted average daily per capita reduction in water consumption achieved was 0.6 gallons per capita per day (gcpd). It is important to note that in both of these studies, kitchen faucets in each household were retrofitted with 2.2 gpm pressure compensating aerators. While these retrofits contributed in part to overall reductions in household water consumption, the retrofits simply brought those kitchen sink faucets up to current water-efficiency standards, therefore, WaterSense decided to set aside this confounding influence in order to estimate the water savings. Assuming the average household consists of 2.6 people, this equates to an average annual household savings of approximately 570 gallons of water (see Calculation 1).

Calculation 1. Average Household Water Savings

$$0.6 \text{ gpcd} \cdot 2.6 \text{ people/household} \cdot 365 \text{ days} = 570 \text{ gallons annually}$$

Extrapolated to the national level, potential estimated water savings could be as great as 61 billion gallons annually (see Calculation 2). These estimates clearly demonstrate the significant water savings potential of high-efficiency lavatory faucets and accessories.

Calculation 2. National Water Savings

$$570 \text{ gal/year} \cdot 107,574,000^{10} \text{ occupied residences w/ plumbing fixtures} = 61 \text{ billion gallons}$$

Based upon these estimates, the average household could save more than 70 kWh of electricity (see Calculation 3) or 350 cubic feet of natural gas (see Calculation 4) each year. National savings could exceed 3 billion kWh hours and 20 billion cubic feet (Bcf) of natural gas each year (see Calculations 5 and 6).

Calculation 3. Electricity Saving Per Household

$$(570 \text{ gal/year} \cdot 0.70) \cdot (176.5 \text{ kWh of electricity/1,000 gal}) = 70 \text{ kWh of electricity per year}$$

Calculation 4. Natural Gas Savings Per Household

$$(570 \text{ gal/year} \cdot 0.70) \cdot (0.8784 \text{ Mcf of natural gas/1,000 gal}) = 0.35 \text{ Mcf (350 cubic feet) of natural gas per year}$$

Calculation 5. National Electricity Savings Potential

$$(61,000,000,000 \text{ gal} \cdot 0.70 \cdot 0.40) \cdot (176.5 \text{ kWh of electricity/1,000 gal}) = 3 \text{ billion kWh of electricity nationwide}$$

Calculation 6. National Natural Gas Savings Potential

$$(61,000,000,000 \text{ gal} \cdot 0.70 \cdot 0.56) \cdot (0.8784 \text{ Mcf of natural gas/1,000 gal}) = 20 \text{ million Mcf of natural gas nationwide} = 20 \text{ Bcf of natural gas nationwide}$$

These calculations are based upon the following assumptions:

- Approximately 70 percent of faucet water used in a household is hot water (Tampa and Seattle Aquacraft studies).
- 42,788,000 (approximately 40 percent) of occupied residences in the United States heat their water using electricity.¹¹
- 60,222,000 (approximately 56 percent) of occupied residences in the United States heat their water using natural gas.¹²

¹⁰ U.S. Department of Housing and Urban Development and U.S. Census Bureau. American Housing Survey for the United States 2005. Table 1A-4 page 5.

¹¹ U.S. Department of Housing and Urban Development and U.S. Census Bureau. American Housing Survey for the United States 2005. Table 1A-5, page 6.

¹² U.S. Department of Housing and Urban Development and U.S. Census Bureau. American Housing Survey for the United States 2005. Table 1A-5, page 6.

- Water heating consumes 0.1765 kWh of electricity per gallon of water heated assuming:
 - Specific heat of water = 1.0 BTU/lb · ° F
 - 1 gallon of water = 8.34 lbs
 - 1 kWh = 3,412 BTUs
 - Incoming water temperature is raised from 55° F to 120° F (Δ 65 ° F).
 - Water heating process is 90 percent efficient, electric hot water heater.

Calculation 7.

$$[(1 \text{ gal} \cdot 1.0 \text{ BTU/lbs} \cdot ^\circ \text{F}) (1\text{KWh}/3,412 \text{ BTUs}) / (1 \text{ gallon}/8.34 \text{ lbs}) \cdot 65^\circ \text{F}] / 0.90 = 0.1765 \text{ kWh/gal}$$

- Water heating consumes 0.8784 Mcf of natural gas per 1,000 gallons of water heated assuming:
 - Specific heat of water = 1.0 BTU/lb · ° F
 - 1 gallon of water = 8.34 lbs
 - 1 Therm = 99,976 BTUs
 - Incoming water temperature is raised from 55° F to 120° F (Δ 65 ° F)
 - Water heating process is 60 percent efficient, natural gas hot water heater

Calculation 8.

$$[(1 \text{ gal} \cdot 1.0 \text{ BTU/lbs} \cdot ^\circ \text{F}) (1\text{Therm}/99,976 \text{ BTUs}) / (1 \text{ gallon}/8.34 \text{ lbs}) \cdot 65^\circ \text{F}] / 0.60 = 0.009053 \text{ Therms/gal}$$

Calculation 9.

$$0.010428 \text{ Therms/gal} \cdot 1,000 \text{ gal} \cdot 1\text{Mcf}/10.307 \text{ Therms} = 0.8784 \text{ Mcf/kgal}$$

Cost Effectiveness and Payback Period

The average homeowner retrofitting their lavatory faucets with WaterSense labeled high-efficiency lavatory faucet accessories (e.g., aerator, laminar flow device, flow restrictor) will realize accompanying \$3.26 savings on water and wastewater cost annually due to lower water consumption (see Calculation 10).

Calculation 10. Annual Water and Wastewater Cost Savings
 $570 \text{ gallons/year} \cdot \$5.72/1,000 \text{ gallons}^{13} = \$3.26/\text{year}$

Factoring in the accompanying energy savings, the average household with electric water heating may save an additional \$6.65 (70 kWh/year · \$.095/kWh), for a combined annual savings of \$9.91. The average household with natural gas water heating, may save an additional \$4.56.(0.35 Mcf/year · \$13.04/Mcf), for a combined annual savings of \$7.82.

¹³ Raftelis Financial Consulting. Water and Wastewater Rate Survey. American Water Works Association. 2004.

Assuming that the average household has two lavatory faucets¹⁴, replacing the aerators in each lavatory faucet with a WaterSense labeled aerator would save \$1.63 per faucet on annual water and wastewater costs. The average payback period for the replacement of two lavatory faucet aerators would be approximately 10 months for those with electric water heating and 12 months for those heating with natural gas (See Calculations 11 and 12).

Calculation 11. Average Payback Period (Electric Water Heating)
 $\$8.00 / [\$3.26/\text{year} + (70 \text{ kWh}/\text{year} \cdot \$0.095/\text{kWh})] = 0.8 \text{ years } (\sim 10 \text{ months})$

Calculation 12. Average Payback Period (Natural Gas Water Heating)
 $\$8.00 / [\$3.26/\text{year} + (0.35 \text{ Mcf}/\text{year} \cdot \$13.04 /\text{Mcf})] = 1.0 \text{ years } (\sim 12 \text{ months})$

These calculations are based upon the following assumptions:

- WaterSense labeled retrofit devices retail for \$4.00 each.
- Average cost of electricity is \$0.095/kWh¹⁵.
- Average cost of natural gas is \$13.04/Mcf¹⁶.

Unit Abbreviations:

Bcf = billion cubic feet

BTU = British thermal unit

F = Fahrenheit

gal = gallon

gpcd = gallons per capita per day

gpm = gallons per minute

kgal = kilogallons

kWh = kilowatt hour

lbs = pounds

L/min = liters per minute

Mcf = thousand cubic feet

psi = pressure per square inch

WaterSense assumes that the cost of new faucets manufactured and sold as WaterSense labeled fixtures will not increase significantly since in many cases the manufacturer will simply need to substitute the current flow regulating device with a similar, more efficient rated device. In many cases this will be as simple as switching from the current 2.2 gpm aerator or laminar flow device to a comparable 1.5 gpm WaterSense labeled device

¹⁴ U.S. Department of Housing and Urban Development and U.S. Census Bureau. American Housing Survey for the United States 2005. Table 1A-3 page 4.

¹⁵ Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, Energy Information Administration. <www.eia.doe.gov/cneaf/electricity/epa/epat7p4.html>

¹⁶ Short-Term Energy Outlook, Energy Information Administration. <www.eia.doe.gov/steo>