WaterSense High-Efficiency Bathroom Sink Faucet Specification Supporting Statement

I. Introduction

The WaterSense Program is developing product performance criteria for high-efficiency bathroom sink faucets. The intent of this High-Efficiency Bathroom Sink Faucet Specification (Specification) is to promote and enhance the market for water-efficient faucets and allow consumers to identify and differentiate those products that have met criteria for water-efficiency and performance.

This Specification addresses those faucet types typically found in bathrooms in residential and other light commercial settings, such as the lodging industry, restaurants, and office buildings. 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 lavatory faucets typically found in public restrooms (e.g., airports, theaters, arenas, stadiums), which already have national performance standards and criteria to which they conform.

II. Current Status of Faucets

WaterSense estimates that currently there are 222 million residential bathroom faucets in the United States. This estimate is based on an assumed one-to-one ratio of bathroom faucets to bathrooms.[1] 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. Of these 25 million faucets, roughly two-thirds of those are bathroom sink faucets (approximately 17 million units).[2] Residential bathroom and kitchen faucets account for approximately 15.3 percent of indoor residential water use in the United States[3]—equivalent to more than 1.1 trillion gallons of water consumed each year.

The Energy Policy Act of 1992 originally set the maximum flow rate for both lavatory[4] 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 Department of

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1 U.S. Census Bureau, American Housing Surveys for the United States, 1970-2003.
2 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>
3 Mayer, Peter W. and William B. DeOreo. Residential End Uses of Water. Aquacraft, Inc. Water Engineering and Management. American Water Works Association. 1998.
4 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 other than public lavatory or metering faucets.

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 Bathroom Sink Faucet Specification

Scope

The WaterSense Program developed this Specification to address criteria for improvement and recognition of water-efficient and high-performance bathroom sink faucets and faucet accessories[5] specifically designed to control the flow of water. This Specification focuses specifically on the category of bathroom sink faucets because of the differences in the uses and performance expectations between bathroom sink faucets and kitchen or commercial faucets. Bathroom sink 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' engineering staff provided a general consensus that a reduction in the maximum flow rate from 2.2 gpm to the proposed 1.5 gpm is not very noticeable for most users. The most noticeable differences are slightly 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 bathroom sink faucets (i.e., washing and rinsing) outweigh any potential inconvenience caused by increased wait times and will not negatively impact overall user satisfaction.

User satisfaction data collected from two retrofit studies conducted by Aquacraft, Inc. in Seattle, Washington (2000)[6] and East Bay Municipal Utility District, California (2003)[7] in which existing bathroom sink faucet aerators were replaced with 1.5 gpm pressure compensating aerators, demonstrated a high level of user satisfaction with high-efficiency faucets. 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 friends. In the EBMUD study, 80 percent of the participants felt their faucet with the new aerators performed the same or better than their old faucet fixtures and 67 percent stated they would recommend these aerators to friends. A third retrofit study conducted in Tampa, Florida (2004)[8] replaced existing bathroom sink faucet aerators with 1.0 gpm pressure compensating aerators. The participants in this study were receptive to an even higher-efficiency fixture, with

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[5] 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.

[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.

89 percent saying their new aerators performed the same or better than their old faucet fixtures and would recommend them to their friends.

The different uses and user expectations for kitchen sink faucets require a different approach. One major 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 simply reducing the maximum flow rates of kitchen faucets would create issues of user satisfaction and be counter to its program goals of 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 bathroom sink 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 lavatory and metering faucets 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 bathroom sink faucets in homes and in light commercial settings, which face a myriad of uses. As a consequence, the maximum flow rate for these public lavatory and metering fixtures can be set significantly lower than the flow rate for bathroom sink faucets found in homes and light commercial settings without negatively impacting user satisfaction. Also, a separate set of standards already apply to these types of fixtures. Codified in the *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–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. This decision was based on several factors. First, lowering the maximum flow rate from 2.2 gpm to 1.5 gpm (both at 60 psi) represents a 32 percent decrease, 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. Second, WaterSense chose 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 bathroom sink faucets would receive a 5 out 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 stakeholders, WaterSense was aware that performance of water-efficient bathroom sink faucets is significantly impacted at low water pressures. To ensure user satisfaction with WaterSense labeled bathroom sink faucets across a range of possible user conditions, WaterSense has established a minimum flow rate of 1.2 gpm at 20 psi in the Specification. This performance criterion was specifically designed to address concerns over user satisfaction in areas with low water pressure, such as might occur in homes that obtain their water supply from private wells. WaterSense is seeking to provide a satisfactory high-efficiency bathroom sink faucet to all users.

In order for high-efficiency bathroom sink faucets to effectively emerge on 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 bathroom sink 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 the 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 East Bay Municipal Utility District (2003) Aquacraft retrofit studies, which provided actual water consumption reductions generated by the installation of high-efficiency, pressure-compensating 1.5 gpm aerators on bathroom sink 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 gpcd · 2.6 people/household · 365 days = 570 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 bathroom sink faucets.

Calculation 2.National Water Savings

570 gal/year · 107,574,000 occupied residences w/ plumbing fixtures = 61 billion gallons

Based upon these estimates, the average household could save more than 81 kWh of electricity (see Calculation 3) or 400 cubic feet of natural gas (see Calculation 4) each year. National savings could exceed 3 billion kWh hours and 24 billion cubic feet (Bcf) of natural gas each year (see Calculations 5 and 6).

Calculation 3. Electricity Saving Per Household

(570 gal/year · 0.70) · (203.6 kWh of electricity/1,000 gal) = 81 kWh of electricity per year

Calculation 4. Natural Gas Savings Per Household

(570 gal/year · 0.70) · (1.011 Mcf of natural gas/1,000 gal) = 0.40 Mcf (400 cubic feet) of natural gas per year

Calculation 5. National Electricity Savings Potential

(61,000,000,000 gal · 0.70 · 0.40) · (203.6 kWh of electricity/1,000 gal) = 3 billion kWh of electricity nationwide

Calculation 6. National Natural Gas Savings Potential

(61,000,000,000 gal · 0.70 · 0.56) · (1.011 Mcf of natural gas/1,000 gal) = 24 million Mcf of natural gas nationwide = 24 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.[9]
- 60,222,000 (approximately 56 percent) of occupied residences in the United States heat their water using natural gas.[10]
- Water heating consumes 0.2 kWh of electricity per gallon of water heated assuming:
  - Specific heat of water = 1.0 BTU/lb · º F
  - 1 gallon of water = 8.34 lbs
  - 1 kWh = 3,412 BTUs
  - Incoming water temperature is raised from 55º F to 130º F (∆ 75 º F)
  - Water heating process is 90 percent efficient, electric hot water heater

[9] 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 6

[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 6

Calculation 7.
[(1 gal · 1.0 BTU/lbs · º F) (1KWh/3,412 BTUs) / (1 gallon/8.34 lbs) · 75º F] / 0.90
= 0.2036 kWh/gal

- Water heating consumes 1.0117 Mcf of natural gas per 1,000 gallons of water heated assuming:
    - Specific heat of water = 1.0 BTU/lb · º F
    - 1 gallon of water = 8.34 lbs
    - 1 Therm = 99,976 BTUs
    - Incoming water temperature is raised from 55º F to 130º F (Δ 75 º F)
    - Water heating process is 60 percent efficient, natural gas hot water heater

Calculation 8.
[(1 gal · 1.0 BTU/lbs · º F) (1Therm/99,976 BTUs) / (1 gallon/8.34 lbs) · 75º F] / 0.60
= 0.010428 Therms/gal

Calculation 9.
0.010428 Therms/gal · 1,000 gal · 1Mcf/10.307 Therms = 1.0117 Mcf/kgal

<u>Cost Effectiveness and Payback Period</u>
The average homeowner retrofitting their bathroom sink faucets with a WaterSense labeled high-efficiency bathroom sink accessory (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 gallons/year · $5.72/1,000 gallons[11] = $3.26/year

Factoring in the accompanying energy savings, the average household with electric water heating may save an additional $7.70 (81 kWh/year · $.095/kWh), for a combined annual savings of $10.96. The average household with natural gas water heating, may save an additional $5.54 (0.4 Mcf/year · $13.84/Mcf), for a combined annual savings of $8.80. The average payback period for a household with only one bathroom sink faucet would be approximately 11 months for those with electric water heating and 13 months for those heating with natural gas (See Calculations 11 and 12).

Calculation 11.Average Payback Period (Electric Water Heating)
$10.00 / [$3.26/year + (81 kWh/year · $.095/kWh)] = 0.9 years (~11 months)

Calculation 11.Average Payback Period (Natural Gas Water Heating)
$10.00 / [$3.26/year + (0.40 Mcf/year · $13.84/Mcf) = 1.1 years (~13 months)

These calculations are based upon the following assumptions:
- WaterSense labeled retrofit device retails for $10.00

[11] Raftelis Financial Consulting. Water and Wastewater Rate Survey. American Water Works Association. 2004.

- Average cost of electricity is $0.095/kWh[12]
- Average cost of natural gas is $13.84/Mcf[13]

Unit Abbreviations:
Bcf = billion cubic feet
BTU = British thermal unit
F = Fahrenheit
gal = gallon
gpcd = gallons per capita per day
kgal = kilogallons
kWh = kilowatt hour
lbs = pounds
Mcf = thousand cubic feet

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, lower 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 pressure-compensating device.

IV. Request for Comments and Data

At this time WaterSense is interested in receiving comments on any and all aspects of the proposed Specification. WaterSense is also interested in receiving any data relating to the performance or water savings of high-efficiency faucets or faucet accessories. This includes descriptions and data for new or emerging faucet technologies or designs not currently covered by this specification.

[12] Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, Energy Information Administration. <www.eia.doe.gov/cneaf/electricity/epa/epat7p4.html>
[13] Short-Term Energy Outlook, Energy Information Administration. <www.eia.doe.gov/steo>