Lavatory Faucets & Faucet Accessories

Response to California Energy Commission
2013 Pre-Rulemaking Appliance Efficiency
Invitation to Participate

Docket Number: 12-AAER-2C; Water Appliances

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Summary

CEC has an excellent opportunity to explore energy efficiency standards for lavatory faucets. In California per year, residential lavatory faucets use a significant amount of water—approximately 40 billion gallons—and both direct energy from electric and natural gas water heating and indirect embedded energy from the supply, treatment and distribution of water. Even with existing standards, there is further opportunity for cost-effective energy savings. Efficiency for lavatory faucets and faucet accessories is often achieved by replacing the faucet aerator with little effect on the overall aesthetic of the faucet, at zero to little incremental cost. Moreover, studies have shown a high level of user satisfaction for high efficiency faucets.

There are many data sources available to the CEC including the extensive research the EPA WaterSense program developed in support of the WaterSense Specification for Lavatory Faucets and Faucet Accessories. WaterSense also maintains a database of WaterSense Labeled products. Additionally, Aquacraft Inc. maintains publically available reports on end water use, water consumption, and water savings.

Table *of* Contents

1 Basic Information

1.1 Product Definition and Scope

Title 20 currently covers lavatory faucets, kitchen faucets, metering faucets, replacement aerators for lavatory faucets, and replacement aerators for kitchen faucets.

In a modern faucet, both the faucet tap mechanism and the faucet accessory work together to control the flow of water to the end user. The faucet tap mechanism controls the amount of water entering the faucet from the building main water supply whereas the faucet accessory controls the flow rate of water that is discharged from the faucet. Figure 1 below illustrates this relationship between faucet tap mechanism and faucet accessory.

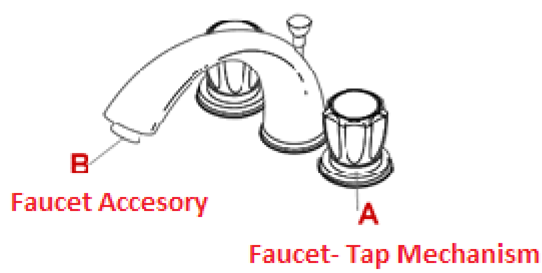

Figure 1 Basic Lavatory Faucet Diagram: A) Faucet Tap Mechanism which controls the main water flow and B) Faucet Accessory for further restriction of water flow
Source: Delta Faucet, 2013.

Faucet accessories are often the main flow control mechanism used to meet the minimum and maximum flow rates of current California faucet flow rate standards. There are two types of faucet accessories: restricting devices and regulating devices. A restricting device regulates flow by physically narrowing the opening through which water exits the faucet. A regulating device adapts the size of the opening based on fluctuations in water pressure to maintain a constant flow rate. These two types of accessories are offered in a single faucet accessory housing or as an insert that can fit into the current faucet accessory housing by the end-user.

The current Title 20 standards only cover replacement aerators. The definition of replacement aerators should be modified to ensure that all flow restricting accessories (flow regulators, aerator devices, and laminar devices etc.) are covered products.

1.2 Sources of Test Data

- **Aquacraft Inc.:** Aquacraft Inc. maintains a database of publically available reports on end water use, water consumption, and water savings: http://www.aquacraft.com/publications-reports
- **WaterSense:** WaterSense maintains a database of WaterSense Labeled products: http://www.epa.gov/watersense/product_search.html

- **CEC Appliance Efficiency Database:** CEC's Appliance Efficiency Database includes faucet and faucet accessories:
- **DOE Compliance Certification Database**: DOE's Compliance Certification Database includes faucet and faucet accessories:

  http://www.regulations.doe.gov/certification-data/CCMS-41431717377.html

1.3 Existing Standards and Standards under Development

1.3.1 Federal Appliance Standards

In the 1980s and early 1990s several states, including California, had established water efficiency standards for faucets. Congress used these state-level standards as the basis for nation-wide standards that were enacted with the Energy Policy Act of 1992. The federal standards that took effect in 1994 are 2.2 gallons per minute (gpm) when measured at a water pressure of 60 pounds per square inch (psi) for lavatory faucets, lavatory replacement aerators, kitchen faucets, and kitchen replacement aerators and 0.25 gallons per cycle (gal/cycle) for metering faucets.

According to federal law, if ASME revises the standard, DOE must review ASME's action and consider adjusting the federal standards. If ASME does not revise the standard after any period of five consecutive years, DOE must issue a final rule waiving Federal preemption and thereby allowing states to set more stringent state-level standards. ASME did not update the standard for five years, triggering DOE to waive preemption.

On December 22, 2010, the DOE issued a final rule that waived Federal preemption for energy conservation standards with respect to any state regulation concerning the water use or water efficiency of faucets, showerheads, water closets, and urinals. This waiver allows states to set their own standards for the relevant plumbing products as long as the state standard is more stringent than the federal standard. [1] Currently the only state that has set a standard more stringent than the federal standard is Georgia, requiring a maximum flow rate of 1.5 gpm at 60 psi (Tolleson 2009) effective July 1st, 2012. The City of New York has also adopted the same standard and effective date (Lappin et. al 2010), as has the City of Los Angeles with an effective date of September 4, 2009 (Los Angeles 2009a).

1.3.2 California Standards

Current Title 20 Standards

Standards current Title 20 standards are consistent with the federal standards, or 2.2 gpm measured at 60 psi for lavatory faucets, kitchen faucets, and replacement aerators, and 0.25 gal/cycle for metering faucets.

Requirements Enacted by SB 407 (2009)

In 2009, the California Legislature enacted Senate Bill 407 (Padilla 2009). This bill requires that plumbing fixtures installed in residential and commercial buildings constructed before 1994 be replaced with more efficiency fixtures by 2017 (single-family buildings) or 2019 (multi-family and commercial buildings). Toilets, urinals, showerheads, and faucets are the plumbing fixtures subject to the rules SB 407 established.

[1] 75 CFR 245 (2010-12-22) pg. 80289–80292

CalGreen (Part 11 of Title 24) Standards

The California Green Building Code, which is also known as CALGreen or Part 11 of Title 24, includes mandatory water efficiency standards faucets. CalGreen 2010 requires a 20 % reduction below the current federal standards for faucets, showerheads, and water closets, which may be achieved either by each individual fitting and fixture or by all fittings and fixtures in a building as a group. Effective January 1, 2014, CalGreen 2013 repeals the performance option allowing averaging of all fixtures and fittings. Additionally, CalGreen 2013 includes the following standards for residential buildings (CalGreen 2012b):

- Residential lavatory faucets: maximum flow rate of 1.5 gpm at 60 psi; minimum flow rate of 0.8 gpm at 20 psi.
- Lavatory faucets in common and public use areas: maximum flow rate of 0.5 gpm measured at 60 psi.
- Metering faucets: maximum water use of 0.25 gal/cycle
- Kitchen faucets: maximum flow rate of 1.8 gpm measure at 60 psi; may temporarily increase flow to 2.2 gpm measure at 60 psi, but must default back to max flow rate of 1.8 gpm measure at 60 psi.

CalGreen includes the following standards for nonresidential buildings (CalGreen 2012a):

- Kitchen faucets: maximum flow rate of 1.8 gpm measure at 60 psi
- Metering faucets: maximum water use of 0.20 gal/cycle

California Plumbing Code Standards (Part 5 of Title 24)

The 2010 California Plumbing Code (§ 402.1) includes faucet standards that are consistent with the efficiency levels enacted by the current Title 20 and federal standard (2.2 gpm measured at 60 psi). As a building code, the Plumbing Code establishes standards for products installed during new construction or alterations, but the standards do not apply to all products offered for sale in California. The standards in Title 20 are what dictate the efficiency level for all products that are offered for sale in California.

1.4 Product Lifetime

The design life for lavatory faucet accessories is estimated to be10 years (McNeil 2008), while the lavatory faucet tap mechanism may have a longer design life, estimated at 25 years (McNeil 2008). Due to the inherent purpose of the lavatory faucet accessory, homeowners are more likely to replace this part rather than the entire faucet, including the tap mechanism.

1.5 Product Development Trends

No response.

1.6 Design and Sales Cycle

No response.

2 All Water Products

2.1 What are the technology options or features that allow faucets to save water?

Faucet accessories are often the main flow control mechanism used to meet the minimum and maximum flow rates of current California faucet flow rate standards. There are two types of faucet accessories: restricting devices and regulating devices. A restricting device regulates flow by physically narrowing the opening through which water exits the faucet. A regulating device adapts the size of the opening based on fluctuations in water pressure to maintain a constant flow rate. These two types of accessories are offered in a single faucet accessory housing or as an insert that can fit into the current faucet accessory housing by the end-user.

2.2 How much water does each technology option or feature save?

Water savings for faucets are based upon the flow rate of the faucet accessory. Flow rates for accessories vary significantly and range from 2.2 gallons per minute (gpm) to 0.35 gpm (Neoperl 2012). Additionally, energy savings for this measure will be realized in associated savings from a reduction in water use. An estimated 70 percent (Mayer, DeOreo, Lewis 2000; Mayer et. al 2004) of lavatory faucet water use is hot water, and a reduction in water use will equate to a reduction in the gas and electricity used to heat that water. In addition, a reduction in water use will also equate to a reduction in the embedded energy from water treatment, conveyance and distribution as discussed in Section 2.3.

To estimate water savings from faucets, one must first approximate realized flow rates. Faucet flow rates are rated at a pressure of 60 psi. However, this is not an accurate indicator of actual usage as water pressure varies from building to building, and as a result of how wide the faucet is open during use. Instead, water savings for faucets is determined by looking at average realized flow rates which take into account fluctuation in water pressure during faucet usage. Aquacraft, Inc. Water Engineering and Management evaluated realized flow rates of lavatory and kitchen faucets for two water utilities: Seattle Public Utilities (Mayer et. al. 2000) and the Tampa Water Department (Mayer et. al. 2004). The average realized flow rates listed in **Error! Reference source not ound.**.As mentioned, these flow rates are the average of all faucet use – that is, both kitchen and lavatory faucets. Typically, water pressure is lower in lavatory faucets, so lower average realized flow rates may be observed if only looking at lavatory faucets.

Table 1: Per Unit- Average Realized Flow Rates

Rated Flow Rate at 60 psi (gpm)	**Average Realized Flow Rate** (gpm)	**Average Percent Savings** ** (%)
2.2*	1.2	n/a
1.5	1.0	17%
1.0	0.73	39%

* Current federal and Title 20 standard

** Percent savings relative to the current federal and Title 20 standard.

2.3 What are the embedded energy savings from the water saved?

Overview of Embedded Energy in California Water

California consumes about 2.9 trillion gallons of water per year for urban uses (Christian-Smith, Heberger and Luch 2012). Urban uses include outdoor and indoor residential water use; water used in commercial, institutional, and industrial applications; and unreported water use, which is primarily attributed to leaks. The 2.9 trillion gallons of water is associated with approximately 26.4 terawatt hours of embedded electricity. Figures 2 and 3 present the estimated urban water use in 2005 and the associated embedded energy use. Please note the data below is for all faucets, both kitchen and lavatory,

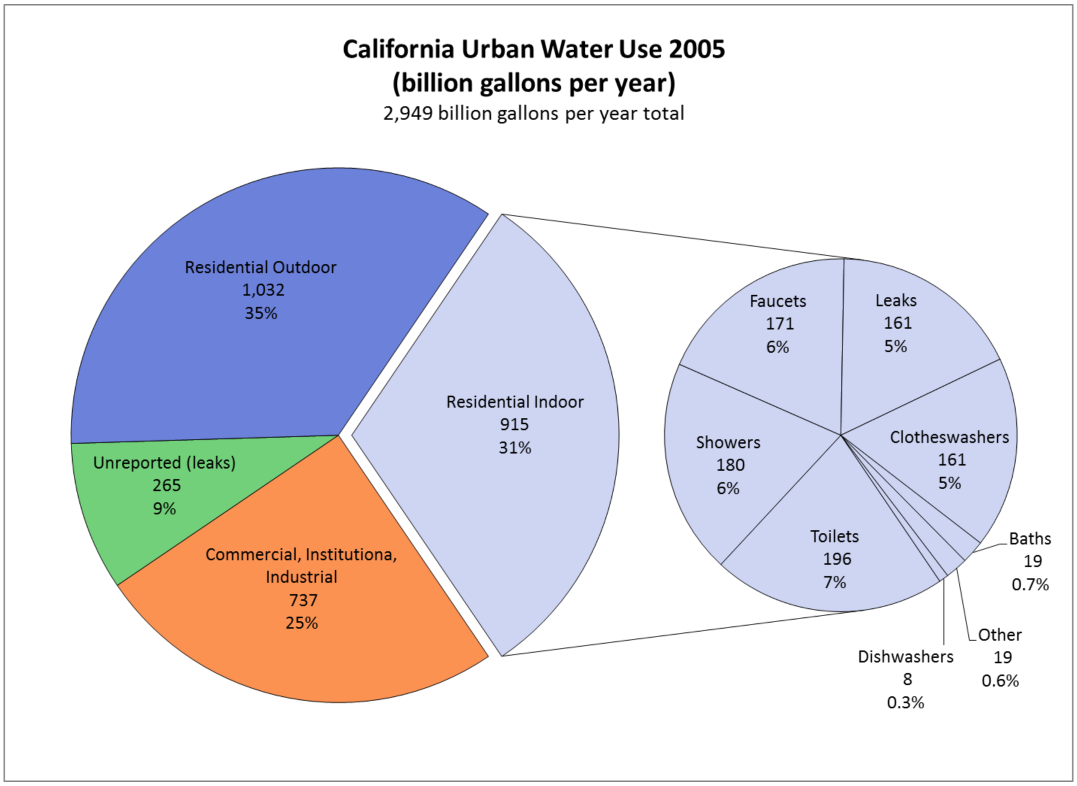

Figure 2: California Urban Water Uses (2005)
Source: Christian-Smith, Heberger, Luch (2012)

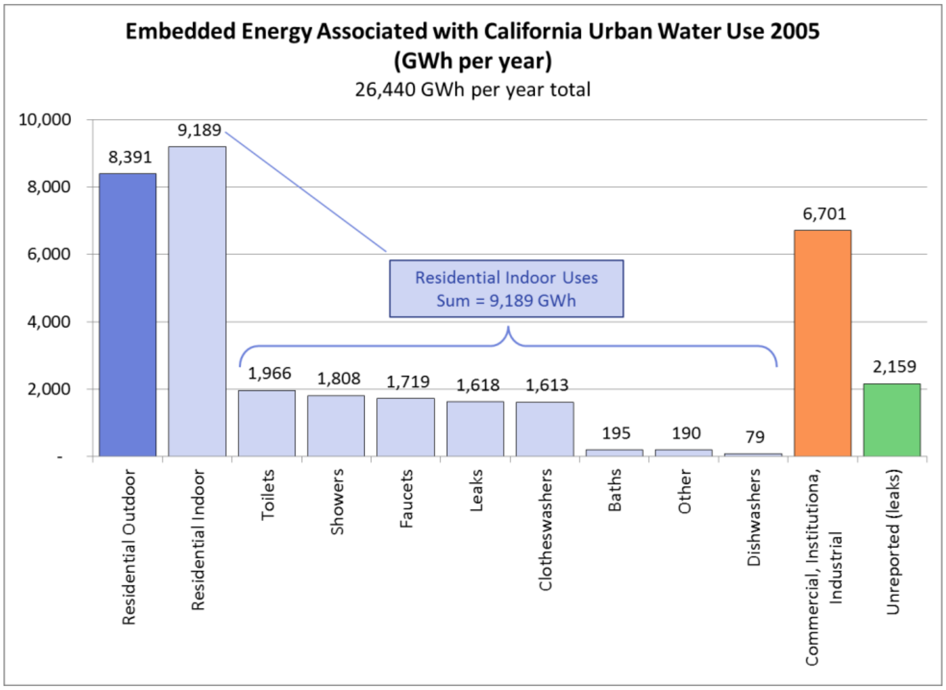

Figure 3: California Urban Water Uses (2005)

Sources: Christian-Smith, Heberger, Luch (2012). Assumptions: Embedded energy factor of 8,134 kWh/MG for residential outdoor water use and unreported (leaks); embedded energy factor of 10,045 kWh/MG for residential indoor; embedded energy factor of 9,090 kWh/MG for commercial, institutional, industrial.

Embedded Energy in Faucets

As shown in Figures 2 and 3 above, residential faucets consume about 171 billion gallons of water per year, which is associated with an embedded energy use of 1,719 GWh of electricity.

Statewide water and embedded energy savings can be approximated by applying the average percent savings to the statewide water and embedded energy consumption estimates presented in Figures 2 and 3. Statewide savings estimates are presented in Table 2, assuming an average flow rate of 2.2 psi. While not included in the below table, additional savings can be realized for faucets rated below 1.0 gpm at 60 psi.

Table 2: Statewide Water and Embedded Energy Consumption and Savings

Flow Rate at 60 psi	**Average Percent Savings**	**Annual Statewide Consumption**		**Annual Statewide Savings**	
(gpm)	(%)	(billion gallons)	(GWh)	(billion gallons)	(GWh)
2.2	n/a	171	1,719	n/a	n/a
1.5	17%	142	1,427	29	292
1.0	39%	104	1,049	67	670

Embedded Energy Factor

Over the past decade, the CEC and the California Public Utilities Commission (CPUC) have made notable progress in understanding the relationship between water and energy in California. However, there is no definitive conclusion on how much water is embedded in California's water, what embedded energy factors should be used for programs that span a wide geographic region, or how water efficiency and water conservation programs might reduce energy used for water supply, conveyance, treatment, distribution, wastewater collect and wastewater treatment. The CEC and CPUC research on embedded energy is referenced below, as is our recommendation on which embedded energy factors should be currently used.

In 2005 and 2006 the CEC published reports that explore how much energy is embedded in water (CEC 2005, CEC 2006). Table 3 shows the embedded energy estimates as presented in the CEC's 2006 report.

Table 3: Embedded Energy Estimates
Source: CEC 2006. Table 7.

	Indoor Uses		Outdoor Uses	
	Northern California kWh/MG	Southern California kWh/MG	Northern California kWh/MG	Southern California kWh/MG
Water Supply and Conveyance	2,117	9,727	2,117	9,727
Water Treatment	111	111	111	111
Water Distribution	1,272	1,272	1,272	1,272
Wastewater Treatment	1,911	1,911	0	0
Regional Total	5,411	13,022	3,500	11,111

CPUC's Decision 07-12-050, issued December 20, 2007, authorized the largest electricity utilities to partner with water utilities and administer pilot programs that aimed to save water and energy (CPUC 2011c). The Decision also authorized three studies to validate claims that saving water can save energy and explore whether embedded energy savings associated with water use efficiency are measurable and verifiable. The pilot programs succeeded at demonstrating that water conservation measures also result in energy savings.

The CPUC studies were effective at obtaining a more granular understanding of how energy use varies based on a number of factors including supply, (i.e. surface, ground, brackish, or ocean desalination), geography, and treatment technology. The authors found "that the value of energy embedded in water is higher than initially estimated in the CEC's 2005 and 2006 studies."

In March 2013, CPUC released additional information on the relationship between water and energy in California. CPUC's work on the water/energy nexus is available here: http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/Water-Energy+Nexus+Programs.htm

Until there is a definitive answer as to which embedded energy factor is most appropriate, we recommend using a population-weighted average of the embedded energy factors for Northern and Southern California presented CEC's 2006 report. We used this methodology to approximate the embedded energy use reported in Figure 3, weighting the values in Table 3 based on the population in Northern and Southern California in 2011 (U.S. Census Bureau).[2] The population-weighted

[2] Northern and Southern California populations are 39.1% and 60.9% of total California population, respectively.

indoor embedded energy factors were used for residential indoor use categories (toilets, faucets, showers, clothes washers, etc.). The population-weighted outdoor values were used for residential outdoor use and unidentified (leaks) categories. For the commercial, institutional, industrial use category indoor and outdoor water use was assumed to be equal.

2.4 How much does each cost a manufacturer to implement on a per product basis?

Based upon the NEOPERL 2012 Wholesale Price List- Catalog 3, there is no price difference between faucet accessories by flow rate. Price differences between Faucet Accessories are often attributed to external factors (flow type, threading, accessory size, style, finish, etc.) rather than efficiency (Neoperl 2012).

3 Information Request for All Products

3.1 What are the annual historic and projected sales of water products from 2009-2015 (in CA and nationwide)?

WaterSense requires manufacturers with WaterSense labeled products to report annually on shipment and sales of WaterSense labeled products and of all products in the same product category.http://www.epa.gov/WaterSense/partners/annual_reporting.html.

3.2 What is the market share of water efficient (or accuracy for water meters) products? Provide a brief description of the performance of the units.

Based upon the DOE Compliance Certification Database (DOE 2013), 37 percent of faucets models have a gpm of 1.6 or higher, 48 percent between 1.5 gpm to 1.01 gpm, 6 percent between 1.0 and .51 gpm, and 9 percent at .50 gpm or lower.

3.3 Is there a difference between units sold to residential and commercial sectors?

We understand there to be no difference between units sold to residential and commercial sectors. However, in practice, non-metering faucets are often installed in residential applications while metering faucets are installed in commercial applications.

3.4 Estimated percentile annual growth sale (CA and nation).

The current California stock estimate is 28 million lavatory faucets. This estimate was derived by analyzing the results of the 2002 East Bay Municipal Utility District (EBMUD) Water Conservation Survey (EBMUD 2002) and using housing construction forecasts that were developed by the CEC for use in the 2013 Building Energy Efficiency Standards rulemaking. The methodology is described below.

The EBUD 2002 survey found that within the EBMUD service area, multi-family households averaged 2.3 faucets per household and single-family households averaged 3.8 per household. The survey also found that 63 percent of faucets in single-family households were lavatory faucets, resulting in 2.4 lavatory faucets per household. We assume for multi-family households only one kitchen faucet per household, resulting in 1.3 lavatory faucets per household. Using the design life estimate of 10 years, the annual sales are estimated to be approximately 2.8 million per year.

3.5 How many small businesses are involved in the manufacture, sale, or installation of these products?

No response.

4 Information Request for All Products

4.1 Are there any test markets for water efficient units?

- There are a number of WaterSense labeled products available on the market today.
- Georgia, the City of New York, and the City of Los Angeles have standards in place that require high efficiency faucets.

4.2 Breakdown of costs per unit by performance

No response.

4.3 Product duty cycle

The 2011 California Single Family Water Use Efficiency Study (DeOreo et. al 2011) found the following:

- 57.4 average faucet events per day per household,
- 37 seconds of faucet use per faucet event,
- 1.1 gpm peak flow rate per faucet event.

5 Consumer Acceptance

5.1 What surveys have been done to gauge consumers' acceptance and performance of more efficient units?

Aquacraft Inc. has maintained publically available reports on the impacts of local and state water districts and governments faucet retrofit programs. These reports look at water consumption and savings as well as user satisfaction surveys. Two of these surveys are:

- *Seattle Home Water Conservation Survey Study: The Impacts of High Efficiency Plumbing Fixture Retrofits in Single-Family Homes* (Mayer et. al 2000) and
- *Tampa Water Department Residential Water Conservation Study: The Impacts of High Efficiency Plumbing Fixture Retrofits in Single-Family Homes* (Mayer et. al. 2004).

5.2 Hot water not arrive for low flow faucets?

Two studies conducted by Aquacraft, Inc. in Seattle, Washington (Mayer, DeOreo, Lewis 2000) East Bay Municipal Utility District (EBMUD 2003) showed a high level of user satisfaction with a 1.5 gpm pressure compensating aerator. These studies show that 58 percent of participants in Seattle and 80 percent of participants in EDMUD felt the high-efficiency aerators performed the same or better than their old fixtures. A study by Aquacraft, Inc. conducted in Tampa, Florida (Mayer et. al 2004), in which 1.0 gpm at 60 psi were installed, found that 89 percent of participants felt the high-efficiency aerators performed the same or better than their old fixtures.

5.3 Is there any problem due to installation of new units, and whether they perform properly with the current plumbing system and codes?

There are no known concerns with performance or compatibility of the new units. All faucet products are held to the same ASME standard, A112.18.1-2011/CSA B125.1-11 (ASME 2011).

6 Information Request for All Products

6.1 Is there a different design duty cycle for the new and existing units? Residential and commercial? What are they?

No Response

6.2 What is the design life of new and existing units?

See 1.4.

6.3 What test methods that were used to test the performance of the appliance?

The current test method in Title 20 is American Society of Mechanical Engineers/ American National Standards Institute (ASME/ANSI) Standard A112.18.1M-1996.

The Department of Energy (DOE) is in the process of updating the test procedures for showerheads, faucets, water closets, urinals, and commercial pre-rinse spray valves. In a Notice of Proposed Rulemaking (NOPR), issued May 2012, DOE proposed to update the test procedure for faucets to ASME/ANSI A112.18.1-2011/CAS B125.1-11 (77 Fed. Reg. 104, 30 May 2012).

Information on the DOE rulemaking is available here:
http://www.regulations.gov/#!docketDetail;D=EERE-2011-BT-TP-0061.

6.4 Was there any difficulty, or issue with the mentioned test methods?

No known difficulty.

6.5 Is there any improvement needed to improve the mentioned test methods?

Not to our knowledge.

7 Information Request for Faucets

7.1 Type of water efficient units and description of their technologies used to achieve the designed performance.

Efficiency for a lavatory faucet or faucet accessory is achieved by lowering the flow rate through the addition of a restricting or regulating flow control device. The capability of achieving high efficiency is a matter of increasing the restriction or regulation of the flow control mechanism. Since faucet accessories are the main method for flow control in faucet, the ease in which a faucet accessory can reach efficiency makes this ability the same for the faucet as a whole.

7.2 Their performance specifications, i.e., gallon per minute.

Faucet performance is measure in gallons per minute (gpm). For metered faucets, gallons per cycle is also used to determine performance.

8 Any other information relevant to this proceeding

No response.

9 References

(References attached separately are highlighted in grey)

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