Work Paper WPSCGNRWH161222A

**Revision 0**

**Southern California Gas Company**

**Customer Programs Department**

**Aerators for Faucets in Commercial Buildings**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Measure Codes** | Com-Aerator-Public-0.5 GPM, Com-Aerator-Public-1.0 GPM, Com-Aerator-Private-0.5 GPM, Com-Aerator-Private-1.0 GPM |
| **Measure Description** | Installation of low-flow faucet aerators (0.5 GPM, 1.0 GPM flow rates) in commercial facilities to reduce water consumption and save energy associated with water heating |
| **Base Case Description** | Existing faucets with max flow rate of 2.2 GPM flow rate or greater |
| **Units** | Per fixture |
| **Energy Savings** | Values averaged for all CA Climate Zones and faucet types:   * 0.5 GPM Aerator: 6.56 therms/fixture * 1.0 GPM Aerator: 3.75 therms/fixture   Refer to Excel Calculations (***Attachment A***) for full savings results for all 16 climate zones. |
| **Full Measure Cost ($/unit)** | $7.17/unit |
| **Incremental Measure Cost ($/unit)** | $7.17/unit |
| **Effective Useful Life** | EUL of faucet: 20 years (EUL ID: WtrHt-WH-Faucet) Measure life = RUL of faucet = 6.67 years |
| **Measure Installation Type** | Retrofit Add-on (REA) |
| **Net-to-Gross Ratio** | 0.7 (DEER NTGR ID: All-Default<=2yrs) |
| **Important Comments** | This work paper has a complementary Ex Ante Database data set that will be provided in a separate submission to the California Public Utilities Commission (CPUC). |

# Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Rev** | **Date** | **Author** | **Summary of Changes** |
| 0 | 12/22/16 | Nicole Loo, SCG | Original workpaper |
|  |  |  |  |

# Commission Staff and Cal TF Comments

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rev** | **Party** | **Submittal Date** | **Comment Date** | **Comments** | **WP Developer Response** |
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# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

Table 1: Base, Standard, and Measure Cases

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | Public Lavatory Faucet Aerator for Commercial Buildings – 0.5 GPM Flow Rate |
| Public Lavatory Faucet Aerator for Commercial Buildings – 1.0 GPM Flow Rate |
| Private Lavatory Faucet Aerator for Commercial Buildings – 0.5 GPM Flow Rate |
| Private Lavatory Faucet Aerator for Commercial Buildings – 1.0 GPM Flow Rate |
| Existing Condition | Faucet with 2.2 GPM max flow rate or greater |
| Code/Standard | 1.2 GPM max flow rate or lower depending on type of faucet (See ***Figure 1***) |
| Industry Standard Practice | Faucet with 2.2 GPM max flow rate or greater |

Table 2: Measure and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
| Com-Aerator-Public-0.5 GPM |  |  |  | Public Lavatory Faucet Aerator for Commercial Buildings – 0.5 GPM Flow Rate |
| Com-Aerator-Public-1.0 GPM |  |  |  | Public Lavatory Faucet Aerator for Commercial Buildings – 1.0 GPM Flow Rate |
| Com-Aerator-Private-0.5 GPM |  |  |  | Private Lavatory Faucet Aerator for Commercial Buildings – 0.5 GPM Flow Rate |
| Com-Aerator-Private-1.0 GPM |  |  |  | Private Lavatory Faucet Aerator for Commercial Buildings – 1.0 GPM Flow Rate |

**Eligibility Requirements**

This energy efficiency measure is applicable to existing faucets in commercial buildings that have a maximum flow rate of 2.2 GPM or greater.

Only facilities that utilize natural gas powered water heating equipment are eligible to receive incentives for this measure. Natural gas must be supplied by an investor owned utilities (IOU).

**Implementation and Installation Requirements**

This measure is to be implemented at private or public lavatory faucets in commercial buildings as a Retrofit Add-on (REA) measure for existing faucets that have a maximum flow rate of 2.2 GPM or greater. These building types include, but are not limited to, restaurants, hotels/motels, schools, universities, university campus housing, retail and offices.

Private lavatory faucets are defined as those that are found in individual dwelling units such as a hotel/motel guest room, dorm room, or nursing home room. Public lavatory faucets are defined as those found in bathrooms shared by a communal area such as a school, restaurant, hotel lobby, or office building.

Faucets at health care facilities that are subject to the Office of Statewide Health Planning and Development (OSHPD) code and regulation (e.g. hospitals, clinics, skilled nursing facilities) are not applicable for this measure. The use of aerators is banned in the health care industry due to the aerator’s flow control methods and components. The mixing of air and water within the aerator allows airborne bacteria to become waterborne and, in warm stagnant conditions, promote bacterial growth. Non-aerating laminar flow restrictors (LFRs) must be installed for faucets in these facilities.[[1]](#endnote-1)

This measure is applicable to all California climate zones and existing building vintages.

## 1.2 Technical Description

Aerators are add-on devices that are installed at the faucet outlet to reduce the flow rate of water. This decrease in flow rate results in a reduction of the energy and water consumed by a faucet over a given operating time. The energy savings is a result of the decreased hot water consumption by the faucet.

Aerators reduce the water coming through a faucet by mixing it with air. Screens are used to introduce air into the water stream, dividing a single stream of water into many tiny streams. Since there is less space for the water to flow through, the flow rate of the water coming out of the faucet is reduced.[[2]](#endnote-2)

## 1.3 Installation Types and Delivery Mechanisms

Table 3: Installation Type Descriptions

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Installation Type** | **Savings** | | **Life** | |
| 1st Baseline (BL) | 2nd BL | 1st BL | 2nd BL |
| Retrofit Add-on (REA) | Above Customer Existing (See ***Section 2.1***) | N/A (Above Code Baseline) | RUL (6.67 years) | EUL – RUL (13.33 years) |

A delivery mechanism is a delivery method paired with an incentive method. Delivery mechanisms are used by programs to obtain program participation and energy savings.

Table 4: Incentive Method Descriptions

|  |  |
| --- | --- |
| **Incentive Method** | **Description** |
| Direct Install (DirInstall) | The program implements energy efficiency measures for qualifying customers, at no cost to the customer. |

## 1.4 Measure Parameters

### 1.4.1 DEER Data

There is no DEER measure for faucet aerators in the commercial sector.

There are, however, two Non-DEER work papers that target the installation of faucet aerators in residential building types:

1. *Faucet Aerators for Bathroom/Kitchen Sinks in Residential Buildings (WPSCGREWH120618A)*
2. *Therm Savings Kit (SCGWP100309A)*

This work paper intends to depart from the Non-DEER faucet aerator work papers since it targets the commercial sector.

Table 5: DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Used for Workpaper?** |
| Modified DEER methodology | No |
| Scaled DEER measure | No |
| DEER Base Case | No |
| DEER Measure Case | No |
| DEER Building Types | Yes: Com |
| DEER Operating Hours | No |
| DEER eQUEST Prototypes | No |
| DEER Version | DEER 2014, READI v2.4.7 |
| Reason for Deviation from DEER | DEER does not contain this type of measure for the commercial sector |
| DEER Measure IDs Used | N/A |

**Net-to-Gross Ratio**

The NTG values were obtained using the DEER READI tool. The relevant NTG values for the measures in this work paper are in the table below.

Table 6: NTG Values

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Measure Delivery** | **NTGR** |
| All-Default<=2yrs | All other EEM with no evaluated NTGR; new technology in program for 2 or fewer years | Any | Any | Any | 0.7 |

DEER NTG values for aerators do not apply because those are targeted for residential markets.

**Spillage Rate**

Spillage rates are not tracked in work papers; they are tracked in an external document which will be supplied to the Commission Staff.

**Installation Rate**

The IR values were obtained using the DEER READI tool. The relevant IR values for the measures in this work paper are in the table below.

Table 7: IR Values

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **GSIA ID** | **Description** | **Sector** | **BldgType** | **ProgDelivID** | **GSIAValue** |
| Def-GSIA | Default GSIA values | Any | Any | Any | 1 |

GSIA values for residential aerators were not used because they do not realistically represent the commercial market.

**Effective and Remaining Useful Life**

Based on the most recent guidance from the CPUC, this measure’s Retrofit Add-on (REA) status dictates that the Remaining Useful Life (RUL) should be used for the savings calculations. The RUL is equal to 1/3 of the EUL of the device being modified by the measure addition, in this case, the faucet. The EUL of a faucet is 20 years based on plumbing publications and manufacturer warranties.[[3]](#endnote-3) [[4]](#endnote-4) [[5]](#endnote-5) From this, the RUL is determined to be 6.67 years.

The relevant EUL and RUL values for the measures in this work paper are in the table below.

Table 8: EUL and RUL Values

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL (Years)** |
| WtrHt-WH-Faucet | Faucet Effective Useful Life | Com | SHW | 20 | 6.67 |

### 1.4.2 Codes and Standards Analysis

Standards for plumbing fittings and fixtures are outlined in California’s Title 20 Appliance Efficiency Program Codes.

Table 9: Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 20 (2016) | Section 1605.1(h). Plumbing Fittings | July 1, 2016 |

Applicable codes for this measure are stipulated in Title 20 of the California Code of Regulations Table H-3 and H-4 in ***Figure 1***. A 2.2 GPM maximum flow rate or greater is used as an eligibility requirement for this measure but is not used as a baseline in the savings calculations due to the strong evidence of higher pre-existing faucet flow rates from the results of the studies in ***Section 1.5.***

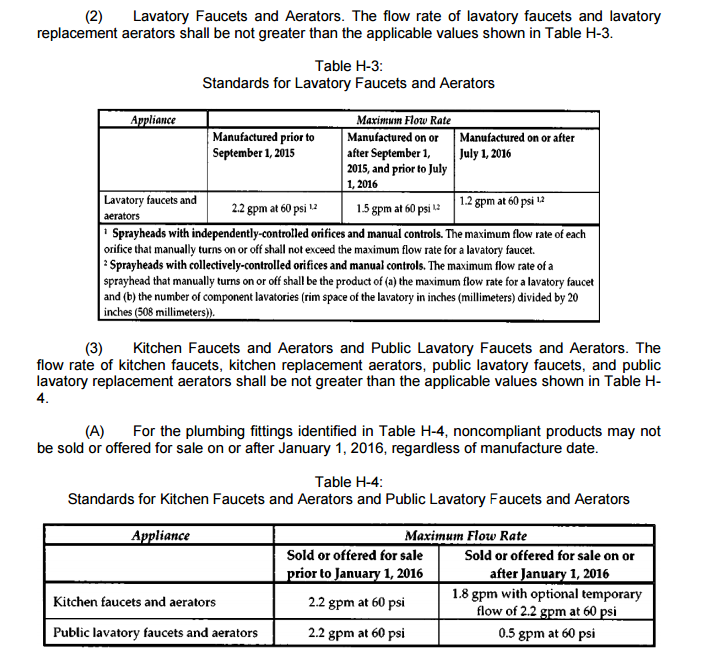


Figure 1: Title 20 Standards for Faucets and Aerators

## 1.5 EM&V, Market Potential, and Other Studies – Base Case and Measure Case Information

The following studies were conducted to estimate baseline water and gas consumption for lavatory faucets in a variety of commercial building types. The results of these studies influence the underlying assumptions used in the savings calculations as seen in ***Section 2***.

### 1.5.1 Savings Calculations for Commercial Faucet Aerator: Baseline Water and Gas Consumption Estimates for Commercial Hot Water Applications

**Overview**

Baseline water and gas consumption for lavatory faucets were estimated for 8 commercial facilities (5 hotels, 2 schools, 1 restaurant). These estimates were prepared by CLEAResult in March 2016 and were determined by reviewing multiple studies on water consumption in commercial buildings. The purpose of this study was to establish baseline consumption values and estimate the savings that occur from the installation of low-flow faucet aerators.

**Techniques Used**

Data from water conservation programs, published studies, and assumptions from statewide technical reference manuals were used to determine the average consumption of water per faucet per year. Engineering calculations and assumptions were used to derive water and energy savings associated with the reduction of flow rate due to the implementation of aerators. The base case was assumed to be existing faucets with a flow rate of 2.2 GPM, while the efficient case was assumed to be a faucet with an aerator installed with a flow rate of 0.5 GPM.

For the hotels, the studies reviewed had indicated that water consumption in the 5 hotels were metered over a short-term period at a whole-building level or sub-metered by room then disaggregated to determine consumption at multiple end uses. These calculations also take occupancy rate of the hotel into account.

For the schools, the studies indicated that water consumption was logged and bills were reviewed. These data points were then disaggregated into annual consumption for multiple end uses. Consumption at lavatory faucets was based on number of flushes occurring per student or employee per day.

For the restaurant, consumption at lavatory faucets was based on the number of flushes.

**Results and Impacts**

The results of this study provide baseline water and gas consumption estimates as well as the estimated savings from the installation of aerators. These results are summarized in **Table 11** and **Table 12** and are explained in full detail in ***Attachment B***.

Table 10: CLEAResult Study Calculated Water Savings (per faucet)

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Baseline Water Consumption, UB (Gallons/Year)** | **Post-Installation Water Consumption, UP (Gallons/Year)** | **Water Savings (Gallons/Year)** |
| **Hospitality** | 1764 | 401 | 1363 |
| **Schools** | 1885 | 428 | 1456 |
| **Restaurant** | 4637 | 1054 | 3583 |

Table 11: CLEAResult Study Calculated Energy Savings (per faucet)

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Baseline Natural Gas Consumption (Therms/Year)** | **Post-Installation Natural Gas Consumption (Therms/Year)** | **Natural Gas Savings (Therms/Year)** |
| **Hospitality** | 7.68 | 1.74 | 5.93 |
| **Schools** | 8.07 | 1.83 | 6.24 |
| **Restaurant** | 20.07 | 4.56 | 15.51 |

The study also indicates that flow rates of up to 3.0 GPM were found at existing fixtures which supports the claim that the Title 20 code is not considered an appropriate baseline flow rate due to strong evidence of a higher pre-existing flow rate.

**Concerns**

The sources reviewed for this study did not directly disaggregate hot water consumption from overall water consumption. Other concerns include the variation in purpose of the faucets and the range in uses per day. It is also not very clear how many faucets would actually benefit from the reduction in flow rate. Because of the limited sample size of commercial buildings and faucets, this study should be taken as a snapshot of the commercial sector and not as a precise representation of the entire sector.

### 1.5.2 Water Consumption Patterns in Hospitals

**Overview**

Water consumption patterns were measured and analyzed for 19 faucets at 3 hospitals over two 10-day periods by Water Saver Solutions, Inc. in 2016. The first 10-day period measured baseline water consumption patterns before the installation of flow control devices. The second 10-day period measured the post-installation consumption patterns. The purpose of this study was to investigate existing water consumption patterns (e.g. time usage per day, gallons of water consumed per day, length of average usage instance, existing faucet flow rates) at various faucet types and determine the impacts of installing faucet flow control devices.

**Techniques Used**

Faucets of various types at each hospital were spot checked and metered over two 10-day periods. These faucet types include: public restroom, private patient room, patient care, nurse stations, and scrub sinks.

Faucets were spot checked using physical measurement techniques. Flow rate measurements were taken using digital flow meters or a flow rate measurement bag. Water temperature coming out of the faucet was determined using a temperature gun.

Flow meters and data loggers were also installed to obtain more detailed consumption data at each faucet. These devices were calibrated to take measurements over two 10-day periods.

**Results and Impacts**

The results of this study provide useful information on the water consumption patterns at existing faucets in large hospitals. These results also help verify the underlying assumptions made in the savings calculations for this workpaper measure such as usage time, existing flow rate, behavioral factor and mixed water temperature coming out of a faucet. Moreover, the results of this study also reveal that faucet usage time is not significantly impacted by the installation of flow restrictors. A sample subset of the data collected can be found in ***Attachment C***.

**Concerns**

One concern would be the small sample size of faucets taken. Only 6 or 7 faucets were monitored at each hospital and it is estimated that each of these facilities has anywhere from 400-800 faucets. Thus, these results should be interpreted as a snapshot of the faucet consumption of a health care facility and not representative of all the faucets of the entire facility as a whole. More monitoring is needed to determine how well the results of these subsets of faucets represent all of the faucets of the hospital as a whole and how they scale to similar but smaller sized facilities such as clinics or nursing homes.

### 1.5.3 Existing Fixtures and Water Consumption Patterns in Hotels

**Overview**

Surveys were conducted by Blackstone Research Solutions, Inc. in 2016 at five hotels to obtain information on the condition of the existing water fixtures at these sites. Faucets at three of the five sites were also metered in order to gather data on water consumption patterns for these building types.

**Techniques Used**

Water fixtures of various types at each hotel were spot checked for flow rate and water temperature. Flow rate measurements were taken using a flow rate measurement bag. Water temperature coming out of the fixture was determined using a temperature gun.

Flow meters and data loggers were also installed at guest room and public restroom faucets at three hotels to obtain more detailed consumption data at each faucet. These devices were calibrated to take measurements over a 10-day period.

**Results and Impacts**

The results of this study provide useful information on the water consumption patterns at existing faucets in hotels. For one, it revealed that although a handful of hotels may already have flow restrictors installed on their faucets, a majority of the hotels surveyed (3 of the 5 sites) did not. These results also help verify the underlying assumptions made in the savings calculations for this workpaper measure such as usage time, existing flow rate, behavioral factor and mixed water temperature coming out of a faucet. A sample subset of the data collected can be found in ***Attachment D***.

**Concerns**

Once again, the main concern about the quality of the data obtained would the limited number of hotels surveyed and faucets sampled. It was also difficult to ensure that the guest rooms were occupied during the duration of the metering. Thus, these results should be interpreted as a snapshot of the faucet consumption of a hospitality facility and not representative of all the faucets of the entire facility as a whole. More monitoring is needed to determine how well the results of these subsets of faucets represent all of the faucets of a hotel as a whole and how they scale to similar but smaller sized facilities such as motels.

### 1.5.4 Market Potential

There are currently approximately 106,100 commercial SCG customers that could benefit from this measure. An estimated number of faucets at each facility type was established using NAICS codes and published studies.

Table 12: Estimated Market

|  |  |  |
| --- | --- | --- |
| **Target Markets** | **Total Customer Counts by NAICS** | **Total Estimated Faucets** |
| Restaurants | 34,000 | 100,000 |
| Hotels/motels | 4,600 | 885,000 |
| Schools | 8,500 | 810,000 |
| Retail | 21,000 | 42,000 |
| Office Buildings | 37,000 | 74,000 |
| Fitness Centers | 1,000 | 11,500 |
| **Totals** | **106,100** | **1,922,500** |

These estimations are likely conservative since they only include a subset of the commercial sector. However, it is also uncertain how many of these estimated faucets already have low flow capabilities or flow restricting devices installed.

## 1.6 Data Quality and Future Data Needs

Overall, the results of these studies are based on a limited sample size of data that was available to be collected. Thus, these results should be interpreted as a snapshot of the faucet consumption patterns of the commercial sector and not representative of all the faucets of the entire sector as a whole. More monitoring is needed to determine how well the results of these subsets of faucets represent all of the faucets of the sector and how they scale to different sized buildings.

# Section 2. Calculation Methodology

## 2.1 Overview and Assumptions

The control volume selected, as seen in **Figure 2,** includes the incoming city make-up water, water heating equipment (e.g. storage water heater, hot water boiler, steam boiler), and the outgoing heated water being supplied to the faucet.

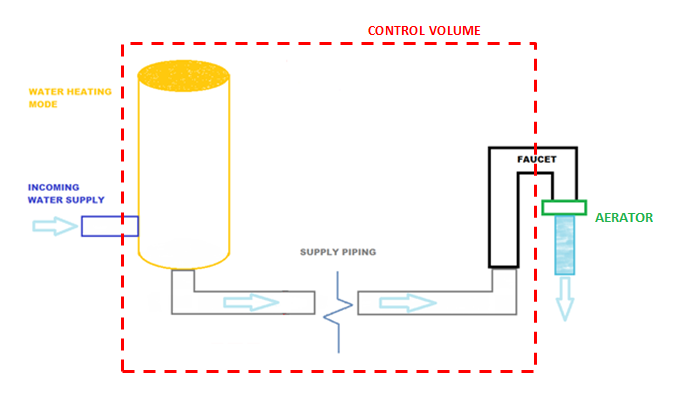


Figure 2: Process Flow and Control Volume

The temperature of the make-up water supplied to the water heating mode varies by climate zone as seen in the table below.

Table 13: Make-Up Water Temperature by Climate Zone[[6]](#endnote-6)

|  |  |
| --- | --- |
| **Climate Zone** | **Temperature (°F)** |
| 1 | 51.38 |
| 2 | 57.29 |
| 3 | 57.05 |
| 4 | 59.51 |
| 5 | 55.83 |
| 6 | 61.75 |
| 7 | 62.55 |
| 8 | 63.74 |
| 9 | 63.82 |
| 10 | 64.15 |
| 11 | 63.19 |
| 12 | 60.88 |
| 13 | 64.1 |
| 14 | 62.67 |
| 15 | 75.47 |
| 16 | 51.75 |

The following assumptions are used in the calculations for this workpaper:

1. Average recovery efficiency of a large natural gas water heater (e.g. storage water heater, hot water boiler) is 76%.[[7]](#endnote-7) [[8]](#endnote-8)
2. A mixed water temperature of 97.9°F is considered an appropriate assumption for faucet use. This was determined from physical water temperature measurements.
3. The average annual operating time per faucet was estimated to be 35 hours per year for a public lavatory faucet (12.4 minutes of usage per day) and 11 hours per year for a private lavatory faucet (3.99 minutes of usage per day). This was determined from analysis of metered data.
4. 3.58 GPM is the average maximum flow rate of an existing faucet. This was determined by taking physical flow rate measurements of faucets when turned on to their full potential flow.
   1. An average behavioral factor of 0.466 is applied to that maximum flow rate to account for human behavior in turning on a faucet since not every operator will turn the faucet on to its full potential flow rate.
   2. Thus, the baseline flow rate used in the savings calculations is **1.67 GPM**. This was determined by analyzing the metered faucet usage data.

Assumptions 2-4 were determined by analyzing the data collected at hospitals and hotels in the studies detailed in ***Sections 1.5.2 and 1.5.3*** ***.*** Relevant portions of this analysis are included in ***Attachment A***.

## 2.2 Gas Energy Savings Estimation Methodologies

The savings calculation approach for this measure compares the energy consumption of the domestic hot water (DHW) system of the existing condition (faucets without aerators) with the proposed condition (faucets with aerators). This analysis is based on the first law of thermodynamics (conservation of energy). The installation of aerators reduces the mass flow rate of water demanded by the system, leading to a decrease in overall water consumption. This reduction in overall water consumption ultimately translates into energy savings since it results in a reduction of the thermal load of the system.

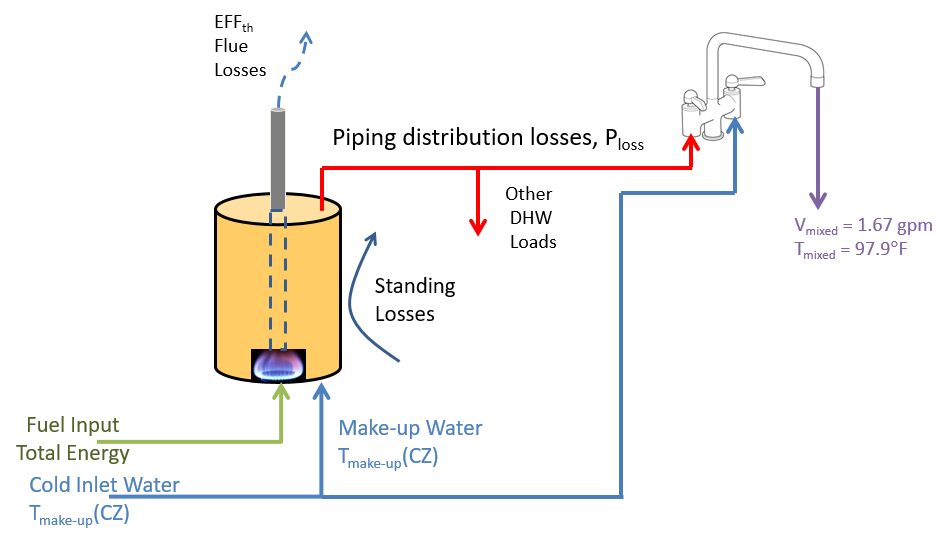


Figure 3: Existing DHW system before the installation of aerators

Equation 1: Annual Energy Consumption of Existing System (No Aerator)

Where,

= annual energy consumption of the existing system,

= annual hot water loads of other hot water using devices (all loads except faucets receiving aerators),

= piping system distribution losses,

= standing loss of hot water heating system,

= existing faucet load (without aerator installed),

= thermal efficiency of water heating equipment, [factor]

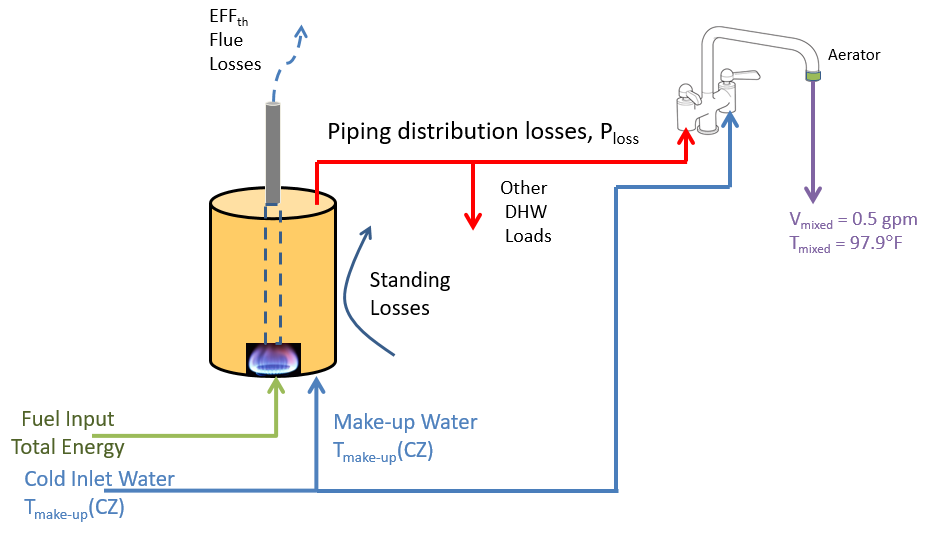


Figure 4: Proposed DHW system after the installation of aerators

Equation 2: Annual Energy Consumption of Proposed System (With Aerator)

The proposed faucet load is similar to the existing faucet load but at the lower flow rate imposed by the aerator installed.

It should be noted that only the *Faucet Load* term in **Equation 1** and **Equation 2** is affected by the installation of the aerator.

The annual energy savings is the difference between the annual energy consumption of the existing system and the annual energy consumption of the proposed system. The terms for all the loads in **Equation 1** and **Equation 2** except the *Faucet Load*, are eliminated when the energy consumption equations are subtracted, resulting in the equation below:

Equation 3: Annual Energy Savings (ES)

The faucet load can be determined by applying the energy flux equation, as seen in **Equation 5**.

Equation 4: Mass Flow Rate

Where,

= mass flow rate,

= volume flow rate,

= density of water,

Equation 5: Energy Flux

Where,

= rate of enthalpy (heat) change,

= specific heat at constant pressure,

= temperature difference,

Applying the conversion factors, annual usage time, and water heating equipment efficiency, the heat flux equation becomes:

Equation 6: Faucet Load ()

Where,

= annual energy consumption per faucet,

= temperature of mixed water stream,

= make-up water temperature (climate zone dependent, see ***Table 14***),   
 = annual operating time,

= thermal efficiency of water heating equipment, [factor]

The net savings is determined from the difference of the energy consumption of the bare faucet and the energy consumption of the faucet with the aerator installed.

Equation 7: Annual Net Energy Savings

## 2.3 Sample Gas Savings Calculation

Assuming that the typical flow rate coming out of a faucet without an aerator is 1.67 GPM, Climate Zone 9 (average make-up water temperature of 63.82°F), storage type water heater with 76% efficiency, mixed water temperature coming out of the faucet of 97.9°F, and typical annual usage of 35 hours per year, the annual hot water load for a faucet without an aerator is:

Substituting the 1.67 GPM term for the flow rate of the installed aerator (i.e. 0.5 GPM) and leaving all remaining terms the same, the annual hot water load for a faucet with an aerator is:

Thus, the natural gas energy savings for that faucet is:

**Table 14** shows the annual savings results per faucet for each of the 16 climate zones. The full savings calculations and results are provided in ***Attachment A***.

Table 14: Annual Savings Per Faucet

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Climate Zone** | **Public Lavatory** | | **Private Lavatory** | |
| **0.5 GPM Aerator (therms/yr)** | **1.0 GPM Aerator (therms/yr)** | **0.5 GPM Aerator (therms/yr)** | **1.0 GPM Aerator (therms/yr)** |
| 1 | 12.49 | 7.15 | 4.02 | 2.30 |
| 2 | 10.90 | 6.24 | 3.51 | 2.01 |
| 3 | 10.97 | 6.28 | 3.53 | 2.02 |
| 4 | 10.30 | 5.90 | 3.32 | 1.90 |
| 5 | 11.29 | 6.47 | 3.63 | 2.08 |
| 6 | 9.70 | 5.56 | 3.12 | 1.79 |
| 7 | 9.49 | 5.43 | 3.05 | 1.75 |
| 8 | 9.17 | 5.25 | 2.95 | 1.69 |
| 9 | 9.15 | 5.24 | 2.94 | 1.69 |
| 10 | 9.06 | 5.19 | 2.92 | 1.67 |
| 11 | 9.32 | 5.34 | 3.00 | 1.72 |
| 12 | 9.94 | 5.69 | 3.20 | 1.83 |
| 13 | 9.07 | 5.20 | 2.92 | 1.67 |
| 14 | 9.46 | 5.42 | 3.04 | 1.74 |
| 15 | 6.02 | 3.45 | 1.94 | 1.11 |
| 16 | 12.39 | 7.09 | 3.99 | 2.28 |

## 2.4 Water Savings Estimation Methodologies

Equation 8: Annual Water Consumption (per faucet)

Where,

= annual water consumption,   
 = volume flow rate,   
 = annual operating time,

Equation 9: Annual Net Water Savings

Table 15: Commercial Aerator Annual Water Savings (per faucet)

|  |  |  |  |
| --- | --- | --- | --- |
| **Savings** | **Faucet Type** | **1.0 GPM (gal/yr)** | **0.5 GPM (gal/yr)** |
| Public Lavatory | 1,402 | 2,449 |
| Private Lavatory | 451 | 788 |

See ***Attachment A*** for full savings calculations and results.

# Section 3. Load Shapes

The hot water demand load profile for commercial building types can be found in DEER-WaterHeater-Calculator-v1.0 provided by DEER.

# Section 4. Costs

## 4.1 Base Case Cost

Baseline costs are $0 since it is an REA measure and the base case would be to do nothing to the faucet.

## 4.2 Measure Case Cost

These measure costs were estimated by averaging existing third party direct install contractor costs for aerator measures.

Table 16: Proposed Measure Costs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Description** | **Delivery Method** | **Equipment Cost** | **Labor/Installation Cost** | **Total Measure Cost** |
| Faucet Aerator (0.5 or 1.0 GPM) | Direct Install | $2.89/fixture | $4.28/fixture | $7.17/fixture |

## 4.3 Full and Incremental Measure Cost

Table 17: Full and Incremental Measure Cost Equations

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| REA | MEC + MLC | MEC + MLC | N/A |

MEC = Measure Equipment Cost; MLC = Measure Labor Cost

Table 18: Full and Incremental Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| REA, Direct Install | $2.89/fixture + $4.28/fixture = **$7.17 per fixture** | $7.17 per fixture | N/A |

# Attachments

Files included in a separate submission.

1. **WPSCGNRWH161222A —Savings Calculations and Assumptions**
2. **WPSCGNRWH161222A –CLEAResult Commercial Faucet Aerator Study**

1. **WPSCGNRWH161222A —Sample Subset of Data Collected at Hospitals**
2. **WPSCGNRWH161222A –Sample Subset of Data Collected at Hotels**

# References

1. (2017, January 1). Section 210.0. *California Plumbing Code (Part 5, Title 24, California Code of Regulations*. <https://law.resource.org/pub/us/code/bsc.ca.gov/gov.ca.bsc.2016.05.pdf>

   [↑](#endnote-ref-1)
2. Umesh, V., Sitaram, N. (2014, July). Hydraulic Performance of Faucet Aerator as Water Saving Device and Suggestions for its Improvements. *International Journal of Research in Engineering and Technology, Volume 3* *(Issue 7)*. <http://www.academia.edu/7815182/HYDRAULIC_PEROFORMNACE_OF_FAUCET_AERATOR_AS_WATER_SAVING_DEVICE_AND_SUGGESTIONS_FOR_ITS_IMPROVEMENTS> [↑](#endnote-ref-2)
3. National Association of Home Builders, Bank of America Home Equity. (2007, February). *Study of Life Expectancy of Home Components*, p. 12. [↑](#endnote-ref-3)
4. Glacier Bay Faucets. 20 Year Warranty Guarantee. [↑](#endnote-ref-4)
5. InterNACHI’s Standard Estimated Life Expectancy Chart for Homes. <http://www.nachi.org/life-expectancy.htm> [↑](#endnote-ref-5)
6. DEER-WaterHeater-Calculator-v1.0, CZ2010 Weather Files for 2013 Title-24. [↑](#endnote-ref-6)
7. *DEER DHW Properties Worksheet*.DEER-WaterHeater-Calculator-v1.0. [↑](#endnote-ref-7)
8. Itron, Inc., (2016, February 23). Combustion Efficiency Analysis, p. 4-9. *2014 Nonresidential Downstream Deemed ESPI Pipe Insulation Impact Evaluation Report*. [↑](#endnote-ref-8)