Work Paper WPSCGNRWH170412A

**Revision 1**

**Southern California Gas Company**

**Customer Programs Department**

**Low Flow Showerheads for Commercial Facilities**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Measure Codes** | Commercial 1.5 GPM LFSH/ Commercial 1.8 GPM LFSH |
| **Measure Description** | Direct Installation of low-flow showerheads, 1.5 gpm & 1.8 gm, in commercial facilities to reduce water consumption and save energy associated with water heating |
| **Base Case Description** | The baseline flow rate is 2.25 GPM for the 1st BL period and 1.8 GPM for the 2nd BL period. |
| **Units** | Per fixture |
| **Energy Savings** | Savings for 1.5 gpm LFSH in climate zone 9, are as follows:  Lodging = 12.81 therms/fixture/yr and  Schools and other Commercial Buildings = 6.27 therms/fixture/yr  Savings for 1.8 gpm LFSH in climate zone 9, are as follows:  Lodging = 7.69 therms/fixture/yr and  Schools and other Commercial Buildings = 3.76 therms/fixture/yr  For details, Refer to Excel Calculation Attachment B |
| **Full Measure Cost ($/unit)** | $45.96 Measure Cost  $31.06 Base Cost |
| **Incremental Measure Cost ($/unit)** | $14.90 |
| **Effective Useful Life** | The low-flow showerhead has an EUL of 10 years and RUL of 3.3 years using DEER READI tool (WtrHt-WH-Shrhd) |
| **Measure Installation Type** | Early Retirement (ER) |
| **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 | 04/27/17 | Raad Bashar, SCG | New work paper |
| 1 | 12/21/17 | Matthew Mendoza, SCG | * Incorporated the responses to the Commission Staff’s comments. * Adjusted and clarified the energy calculations for the Lodging category; Recalculated market occupancy rate as suggested by Comment 4 * Changed the Schools operating days per year, as pointed out by the reviewer in comment-5 * Removed ROB/NC Installation types and PreRebDown delivery type; workpaper will be used strictly as Direct Install |

# Commission Staff and Cal TF Comments

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rev** | **Party** | **Submittal Date** | **Comment Date** | **Comments** | **WP Developer Response** |
| 0 | CS | 6/19/17 | 7/3/17 | **Comment 1.**  Preponderance of Evidence (PoE): Workpaper covers both Accelerated Replacement (AR) and Normal Replacement (NR). AR implementations require evidence that the program was the primary influence to accelerate replacement of the equipment. Provide narrative discussing procedures, collected evidence and contractor requirements that identify PoE of accelerated replacement for these deemed measures.  **Comment 2.**  Existing condition of 2.25 GPM: Commission staff cannot locate a citation for this assumption. Section 1.5.1 notes a study "A comprehensive Energy Audit performed by Blackstone Research Corp., Inc. in 2016 (Attachment 3)" but this study was not uploaded along with the workpaper. Commission staff will review this document once it is uploaded and make a determination if additional research is required to support the existing conditions baseline.  **Comment 3.**  If ISP exceeds code, then ISP shall be the 2nd baseline for AR measures and the baseline for NR measures. Workpaper assumes Title 20 code requirements for maximum flow. However, ISP may be showerheads that exceed have lower flow ratings than the maximum allowed by Title 20. ISP research is required to support using code minimum performance.  **Comment 4.**  Savings assume a 0.77 occupancy fraction for all lodging establishments, which is based on "Southern California Lodging Forecast, PKF Consulting USA  <https://www.cpp.edu/>Collins/  Commission staff could not download this document but found similar documents on-line. These references note out that occupancy rates in southern California are at an all-time high and projects next year's values (0.77) to be even higher. Revise occupancy rate to reflect typical occupancy to be expected over the EUL of the measure, which will likely be lower than 0.77.  **Comment 5.**  Workpaper appears to cover schools, but only Motel, Hotel and Com are included in the ex-ante data. Data for schools appears to be based on a study of two schools that were year around operation, which may not be typical. Expand the analysis for schools to include specific building types (Primary, Secondary, Community College or University) along with the usage assumptions and sources for each of those building types. Do not use Com as a building type in the ex-ante data. Identify specific building types as is the case in the submitted data for Hotel and Motel. | **Response 1:**  From the data collected from the study (#2 below), it was evident that some showerheads in the lodging sectors have high flow rates above 2.5 gpm which had been in code as the maximum showerhead flowrate since 1994. This workpaper covers a LFSH measure that will be implemented through ‘Direct Install’ delivery type in partnership with other POUs such as LADWP or by 3rd party contractors. As specified in Page 8 of the workpaper under Program Restriction and Guidelines in Section 1.1, the implementers will market and identify facilities using higher flow showerheads (2.5 gpm or more) and offer the replacement of the showerheads with 1.8 gpm or 1.5 gpm LFSH. This DI approach will ensure the influence of the program.  The Terms and Conditions section (Section 1.2) of the workpaper outlines the following, “the measure is applicable to replacement (Early Retirement) of the existing showerhead of 2.5 gpm flow rate or greater with a low-flow showerhead of 1.8 gpm or lower flow rate. Water heating source fuel must be natural gas”.  **Response 2:**  The file is attached with this response. SCG will re-submit this file with the revised workpaper. This study audited 5 hotels to collect data related to hot water such as water heater efficiencies and input rates, HW set points, faucet flowrates in guestrooms and public restrooms, showerhead flowrates, hot and cold water temperatures, monitoring of hot and cold flows, etc. *(See Attachment C)*  **Response 3:**  The 1st baseline uses 2.25 gpm which can be found as the pre-existing baseline from SCG’s residential showerhead workpaper. Survey of hotel water fixtures mentioned above (#2) resulted in the average flowrates of showerheads of 2.48 gpm. This workpaper adopted the lower flowrate (2.25 gpm) as the pre-existing baseline.  The 2nd baseline uses 1.8 gpm which will become the code requirement in July 2018 while the current code requirement is 2.0 gpm. AR measure uses the dual baseline savings, and the NR measure uses a single baseline savings with 1.8.  For the case of a 1.8 gpm measure with AR application type (direct install), the second baseline savings would be 0 therms because the measure flowrate is the same as the code requirement. For the case of a 1.5 gpm measure, there would be savings from both baseline periods.  From the hotel surveys mentioned above (#2), the average flowrate of 2.5 gpm meets the previous standard that was in place for the last 22 years. A discussion with or guidance from the EAR team on ISP research to support using code minimum as the baseline will be valuable.  **Response 4:**  The correct link to the document is <https://www.cpp.edu/~collins/partners/outlook-conference/documents/PKFConsulting.pdf>.  This link is still valid, and the file is attached with this document. Please see slides 15~23. It will also be attached to the revised workpaper.  Instead of using a weighted average of 77.2% from the year 2014, which could signify an all-time high, a weighted average across the evaluated years of 2010-2014, 73.17%, was used. This value encompasses the occupancy rates for all SoCal Counties evaluated within the study and will also account for the possible peak in the market that Southern California could be experiencing.  **Response 5:**  In Table 13 of the workpaper and in the calculation worksheet “Showerhead calcs” tab (cell D49), 264-days is used as the school operation days per year. However, it turns out that the number of operation days doesn’t affect the savings after all because the annual operation minutes will remain the same. SCG will revise calculations and clarify how assumptions are used in the analysis.  While the shower facility might be present in various type of buildings such as fitness centers, hospitals, nursing home, schools, municipal buildings, and even in some office buildings, the most of showerheads would be found and frequently used in the lodging sectors. The availability of data on shower usage in non-residential buildings is limited as seen in the analysis of school building type which included data from only two schools. The therms savings for schools are estimated to be much smaller than the savings for hotels and motels due to the lower frequency of use.  SCG understands the rationale behind the EAR comment regarding the applicable building types. However, SCG would like to discuss with the EAR team on possibility of offering the LFSH DI measure in all non-residential buildings to replace the existing showerheads of 2.5 gpm or higher flowrate under AR through direct install. |
| 0 | Cal TF |  |  | * Comment 1 * Comment 2 | * Response 1 * Response 2 |

Cal TF website: <http://www.caltf.org/>

The Cal TF approved the version X of this workpaper found under the “Approved Measures” section of the website, <http://www.caltf.org/approved-measures/>

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# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

This workpaper provides an opportunity for energy savings by installing low-flow showerheads in commercial buildings. This workpaper details the energy savings and other measure parameters for the installation of low flow showerheads rated at 1.5 GPM and 1.8 GPM.

## 1.2 Technical Description

**Low-Flow Showerhead**

Installation of low-flow showerheads in commercial facilities reduces water consumption and saves energy associated with water heating. Studies have shown that there are many commercial buildings in Southern California that can benefit from replacing their existing water fixtures, and specifically, showerheads into low flow fixtures. The economics from such improvements are very cost effective.

By reducing the flow rate, this device will reduce the amount of water consumed. As a result, the water heater energy load will decrease, thus yielding energy and water savings. An existing baseline flowrate of 2.25 GPM is used for the energy savings estimate during the first baseline period. The code required baseline flow rate of 1.8 GPM for the second baseline is used to estimate the energy savings in the second baseline period.

**Program Restrictions and Guidelines**

***Terms and Conditions***

* This workpaper includes only a Direct Install delivery method. All implementers of this measure will market and identify commercial facilities utilizing higher flow showerheads (>2.5 gpm) and offer to replace with high efficiency low flow showerheads (<1.8 gpm).
* Make and model number must be included with a copy of the invoice.
* The measure is applicable to replacement (Early Retirement) of the existing showerhead of 2.5 gpm flow rate or greater with a low-flow showerhead of 1.8 gpm or lower flow rate.
* Water heating source fuel must be natural gas.
* Low-flow showerhead shall meet the requirements of test procedure ANSI/ASME A112.18.1-2000, Section 5.5

**Market Applicability**

* The measures defined in this workpaper are applicable to existing buildings only. Newly constructed buildings, additions to existing buildings, and alterations to existing buildings are excluded.
* Gas savings from these measures will apply to both lodging building types (Hotel/Motel), as well as all other commercial building types. The COM building type designation will include, but is not limited to, educational facilities (University, Public/Private Schools), healthcare facilities, small/large office buildings, fitness centers, and municipal facilities (Recreation centers, parks).

Table : Base, Standard, and Measure Cases

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | 1.8 and 1.5 GPM flow rate |
| Existing Condition | 2.25 GPM flow rate |
| Code/Standard | 2.0 GPM flow rate or lower (2016), 1.8 GPM flow rate or lower (2018) |
| Industry Standard Practice | N/A |

Table : Measures and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
| Commercial 1.5 GPM LFSH |  |  |  | 1.5 GPM Low Flow Showerhead for Commercial Facilities |
| Commercial 1.8 GPM LFSH |  |  |  | 1.8 GPM Low Flow Showerhead for Commercial Facilities |

## 1.3 Installation Types and Delivery Mechanisms

The installation type that is applicable for this measure is Early Retirement (ER).

Table : Installation Type Descriptions

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Installation Type** | **Savings** | | **Life** | |
| 1st Baseline (BL) | 2nd BL | 1st BL | 2nd BL |
| Early Replacement (ER) | Above Customer Existing 2.25 GPM | Above Code or Standard 1.8 GPM | RUL | EUL-RUL |

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 (PreRebDI) | Direct install prescriptive rebate |

## 1.4 Measure Parameters

### 1.4.1 DEER Data

There are currently no DEER measures applicable for low-flow showerheads in commercial buildings. Energy savings will vary with each flowrate of showerhead installed.

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 | No |
| DEER Operating Hours | No |
| DEER eQUEST Prototypes | No |
| DEER Version | No |
| 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: NTGR

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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 |

**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. Though the removal of installed low flow devices may result in a lower installation rate, future studies of the participant’s persistent use of low flow showerheads is needed and may result in a more accurate value for IR.

Table 7: GSIA

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

**Effective and Remaining Useful Life**

The low-flow showerhead has an existing useful life of 10 years and a remaining useful life of 3.3 years. The EUL and RUL values were obtained using the DEER READI tool (WtrHt-WH-Shrhd), with the RUL equaling 1/3 of the EUL.

Though the EUL/RUL is listed in DEER for the residential sector, showerheads are subject to very similar conditions in the commercial sector, regardless of flow rate. Thus, it is expected that all low flow showerheads will have approximately the same EUL. The relevant EUL and RUL values for the measures in this work paper are below.

Table 8: EUL

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL (Years)** |
| WtrHt-WH-Shrhd | Low-Flow Showerhead | Com ”Res” | SHW | 10 | 3.3 |

### 1.4.2 Codes and Standards Analysis

*Title 20:* Title 20 of the California Energy Regulations states that the flow rate of a showerhead shall not be greater than 2.0 GPM at 80 psi if they are sold or manufactured for sale in California prior to July 1, 2018, and 1.8 GPM at 80 psi for after July 1, 2018.

Table 9: Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 20 (2016) | Section 1605.3 (Table H-5). Plumbing Fittings | July 1, 2016 (current)  July 1, 2018 (upcoming) |

This workpaper only includes the Early Retirement (ER) installation type which have dual baselines. The two baselines are defined below:

|  |  |
| --- | --- |
| 1st Baseline: | The first baseline is evaluated using existing conditions, which was found to be 2.25 GPM through the SCG’s field survey (Section 1.5.2). This baseline is evaluated over RUL period. |
| 2nd Baseline: | The second baseline is evaluated using the 2018 code baseline. The current code requirement is 2.0 GPM, which will last until June 30th, 2018. A code update will reduce the flow rate to 1.8 GPM at 80 PSI for all showerheads manufactured on or after July 1st, 2018. The 2nd baseline savings will be calculated using the reduced flow rate of 1.8 gpm for the EUL-RUL period. |

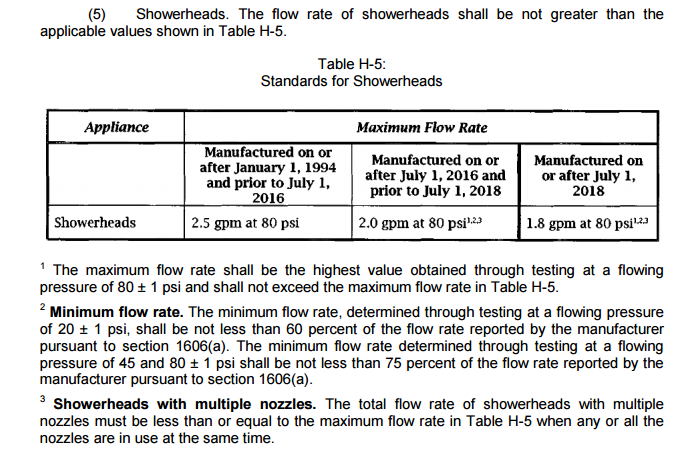


Figure 1: Title 20 Standards for Showerheads

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

Although showers may be present in some offices, manufacturing buildings, etc., this workpaper defines methodology that calculates water and energy savings in hotels and schools only. The workpaper uses the calculated savings for educational facilities as a placeholder for all COM building types.

### 1.5.1 Study Title: Savings Calculations for Commercial Showerheads

A study prepared by CLEAResult in March 2016 *(Attachments A)*

Multiple studies were reviewed to find data that was utilized to determine baseline consumption of water and natural gas in applications using hot water for showers in commercial buildings. Lodging and schools from the commercial sector were selected in this study.

The study provided the information and data used in the development of this workpaper.

### 1.5.2 Field Study: Hot Water Survey in Hotels and Motels in SoCal

An audit performed by Blackstone Research Corp., Inc. in 2016 *(Attachment C)*

This study audited 5 hotels to collect data related to hot water such as water heater efficiencies and input rates, HW set points, faucet flowrates in guestrooms and public

restrooms, showerhead flowrates, hot and cold-water temperatures, monitoring of hot and cold flows, etc. The analysis of the data resulted in an average flowrate for guestroom showerheads at 2.48 gpm. This workpaper adopted the lower flowrate (2.25 gpm) as the pre-existing baseline. The same baseline estimate was used in the water and gas savings calculation for schools.

## 1.6 Data Quality and Future Data Needs

The savings calculations in this workpaper utilized ex ante data for only hotels and schools. Due to lack of data, the savings for educational facilities will applied to all commercial building types. Further testing data (several lodging facilities and different commercial building categories) in-addition to an M&V plan may help in the verification of savings for a more specific subset of commercial building types. The plan can vary in depth and scope, but may include spot measurements, monitoring of fixtures use, and/or utility bill analysis.

# Section 2. Calculation Methodology

Multiple studies were reviewed to find data that was utilized to determine baseline consumption of water and natural gas in applications using hot water in showers.

## 2.1 Data and Assumptions, Conversion factors

Table 10 below, lists the data, assumptions and conversion factors used in the calculations for this workpaper. The results in water and energy savings are listed in Table 14 and Table-15, respectively. For details on the calculations, please refer to the CLEAResult report and calculations in *Attachments A & B*. The water and gas consumption calculations for this measure were developed based on standard engineering methodologies. Data from water conservation programs, published studies, and assumptions provided in technical references were utilized to calculate the average consumption of water per shower per year.

Table 10: Data and Assumptions, & Conversion Factors

|  |  |  |  |
| --- | --- | --- | --- |
| **Constant** | **Description** | **Value** | **Units** |
| V̇base existing | Existing showerhead water flow, *from 2013 SCG Low-Flow Showerheads Work Paper and field study at 5 hotels in SoCal* | 2.25 | GPM |
| V̇base Code 2016 | Baseline showerhead water flow, 2016 code requirement (volumetric flow rate) | 2.0 | GPM |
| V̇base Code 2018 | Baseline showerhead water flow, 2018 code requirement (volumetric flow rate) | 1.8 | GPM |
| V̇post Avg | Post Flow Rate (FP) | 1.5 | GPM |
| Tout, tempered | Mixed Water Temperature (TH), *from the 2013/14 Work Paper Disposition* | 104 | ºF |
| Tin, cold | Supply Water Temperature (T*supply*) | 63 | ºF |
| *ρ* | Density of water at 60 ºF | 62.37 | lbm / ft3 |
| Cvolume | Volumetric conversion constant | 7.481 | gal / ft3 |
| Cmass | Mass conversion factor | 8.33 | lb / gallon |
|  | Specific Heat of Water (Cp) | 1.0 | BTU/lb°F |
| REres,gas | Recovery Efficiency (*Title 20 gas-fired water heaters*) | 0.78 | unitless (heat out / heat in) |
| THgas gal | Base Case Therms/Gallon Consumed | 0.00435 | Therm/Gallon |

Tables 11 and 12, below, define the water and energy variables stated in the calculation formulas for Hotels and Schools.

Table 11: Data and Assumptions for Lodging

|  |  |  |  |
| --- | --- | --- | --- |
| **Constant** | **Description** | **Value** | **Units** |
| OccRateRegional | Regional Lodging Occupancy Rate[[1]](#endnote-1), *Southern California Lodging Forecast* | 73.2% | unitless |
| OccPerRoomNational | National Lodging Average Number of Guests per Room | 1.4 | unitless |
| Days | Lodging /Hospital operating days per year | 365 | days |
| **Case 1, Source used:**  **"Commercial and Institutional End Uses of Water". For the American Water Works Association. 2000****[[2]](#endnote-2)** | | | |
| Vvolume | Annual metered shower water consumption *from five hotels (gallons)* | 11,731,000 | Gallons /yr |
| Nshowers | Total number of Showers | 961 | showers |
| OccRatewtd | Weighted Occupancy rate during testing | 0.82 | unitless |
| OccPerRoomwtd | Average Occupants Per Room | 1.87 | unitless |
| Wbaseline Avg | Base Case Water Consumption per Shower | 12,207 | Gal/shower/yr |
| Wbaseline Avg | Base Case Consumption (*Normalized from the National Ave Rate*) | 8,131 | Gal/shower/yr |
| Etherm baseline Avg | Base Gas Consumption Per Shower Per Year, | 35.38 | Therms / yr |
| **Case 2, Source used:**  **The Potential for Urban Water Conservation in California. Pacific Institute., 2003****[[3]](#endnote-3)** | | | |
| tshower | Minutes Per Room Per Day Usageiii *from Shower Water Use in the CII Industries (2000)* | 16.2 | minutes / shower |
| Wbaseline Avg | Base Water Consumption Per Shower Per Year | 9,734 | Gallons / yr |
| Etherm baseline Avg | Base Gas Consumption Per Shower Per Year | 42.35 | Therms / yr |

Table 2: Data and Assumptions for Schools

|  |  |  |  |
| --- | --- | --- | --- |
| **Constant** | **Description** | **Value** | **Units** |
| OccRateRegional | Total annual metered shower water consumption from two schools (gallons), “*Commercial and Institutional End Uses of Water". For the American Water Works Association. 2000.* | 258,000 | Gallons |
| OccPerSchoolNational | Total number of showers from two schools | 59 | unitless |
| Days | Schools operating days per year; (55hrs/wk\*40wk/yr /10hrs/day)[[4]](#endnote-4) | 220 | days |
| Wbaseline Avg | Base Water Consumption Per Shower Per Year | 4373 | Gallons / shower/ yr |
| tshower-yr | Annual Shower Utilization (minutes per year), *from CLEAResult study data* | 1944 | Minutes / yr |
| Etherm baseline Avg | Base Gas Consumption Per Shower Per Year | 18.73 | Therms / yr |

* 1. Water Consumption Calculations:
* Lodging Savings Calculation\_case-1:

Data from the “*Commercial and Institutional End Uses of Water*” were utilized to determine the average water consumption from showers in individual hotel rooms. Water consumption in five hotels was metered over a short-term period at either a whole-building level or sub-metered by room and then disaggregated to determine consumption at multiple end uses. The data was extrapolated to show annual end use consumption. For the purpose of these calculations, one shower is assumed to be located in each room. As occupancy rates and occupants per room vary, the data from the study were normalized using the weighted occupancy rate during testing and occupants per room to determine the annual consumption per occupant (Wocc).

Additional data (*shown in Table-11*) was utilized to account for regional average of occupancy rate and national average of occupants per room to find the annual average consumption per shower. A study by PKF Consulting done on October 13, 2015 (*Attachment E*), evaluated the Southern California lodging industry for the years from 2010-2015 and forecasted occupancy rates for the year 2016. The study shows that Los Angeles County represents 42% of the total market evaluated within the study and had an 80.0% occupancy rate in 2013, then 81.2% and 81.6% for 2014 and 2015, respectively. This shows that the occupancy rate is slightly rising over the years and has been for all evaluated years. The forecasted occupancy rate was projected to slightly drop by 0.1% in 2016. This projection of a slight drop may be an indication that occupancy rates will be begin to decrease as historical data shows that fluctuation in lodging occupancy rates occur over time. Due to the possibility that the market is on the rise and rates may be at its peak, a weighted average for occupancy rate over the five years of data provided by PKF was calculated. This average rate was found to be 73.17%, which covers the following Southern California counties or areas; Los Angeles, San Diego, Orange County, Santa Barbara, Ventura, Coachella Valley, the Inland Empire, San Luis Obispo, and Southern California Coastal areas. For the purposes of the calculations within this workpaper, the weighted average of 73.17% occupancy rate was used to calculate all lodging related water and gas savings. These calculations can be found in *Attachment B*.

The formula below is used to calculate the normalized annual consumption per shower (Wbaseline), assuming the number of showers identified in the study equal the number of rooms.

The post-retrofit annual consumption per shower (Wpost1) was calculated using the post and existing flow rates:

* Lodging Savings Calculation\_case-2:

Additional data (*from the Potential for Urban Water Conservation in California*) were available allowing for an alternate calculation of water consumption utilizing typical lengths of showers and the above occupancy data. Using an average shower time (t) of 16.2 minutes per occupant per day, the following calculation is used to calculate annual water consumption:

The post-retrofit annual consumption per shower (Wpost2) was calculated using the post and existing flow rates:

The annual consumption for existing and measure case showerheads for both lodging calculation methodologies were then averaged and are presented in *Table-13*.

* Schools Savings Calculation:

Data from *Table-13* was utilized to determine the annual average water consumption from showers in schools. Water consumption was logged and utility billing information were reviewed for four schools. ii

The average base case water consumption for individual showers was calculated as:

The post-retrofit annual consumption per shower (Wpost2) was calculated using the post and existing flow rates:

Summary of the water savings are given in Tables 13 & 14 and more details of the calculations can be found in *Attachment B*.

The savings for Early Retirement (ER) measures will have dual baselines, denoted as first and second baselines. The first baseline savings utilizes a 2.25 GPM flow rate while the second baseline utilizes the 2018 code flow rate of 1.8 GPM.

Table 13: Annual Water Consumption Per Showerhead:

|  |  |  |
| --- | --- | --- |
| Showerhead Type | Lodging | Schools |
| **2.25 GPM Showerhead** | **8,932** | **4,373** |
| **1.5 GPM Showerhead** | **5,955** | **2,915** |
| **1.8 GPM Showerhead** | **7,146** | **3,498** |
| Unit in [gallons / showerhead / year]  Unit in [gallons / showerhead / year]  Unit in [gallons / showerhead / year]  Unit in [gallons / showerhead / year] | | |

Table 14 : Annual Water Savings by Using Low Flow Showerheads (1st Baseline)

|  |  |  |
| --- | --- | --- |
| **Showerhead Type** | **Lodging Savings** | **Schools Savings** |
| 1.5 GPM Showerhead | 2,977 | 1,458  1458 |
| 1.8 GPM Showerhead | 1,786 | 875  875 |
| Unit in [gallons / showerhead / year] | | |

Refer to *Attachment B* to find savings for the first and second baseline for both the 1.5 gpm and 1.8 gpm showerhead measures.

* 1. Energy Savings calculations:

Annual gas consumption is calculated using the equation below:

\*, where,

Where:

* *ρ = Water Density at 60 °F*
* *T = Temperature °F*
* *η =Thermal Efficiency, Commercial Gas Water Heater = .78*

Table 15 Energy Savings (1st Baseline @ 2.25 gpm and LFSH of 1.5 gpm)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Location, Climate Zone** | **Baseline Natural Gas Consumption (Therms/Year)** | **Post-Installation Natural Gas Consumption (Therms/Year)** | **Natural Gas Savings (Therms/Year)** |
| **Lodging** | CZ01 | 50.18 | 33.45 | 16.73 |
| **Lodging** | CZ02 | 44.64 | 29.76 | 14.88 |
| **Lodging** | CZ03 | 44.84 | 29.89 | 14.95 |
| **Lodging** | CZ04 | 42.55 | 28.36 | 14.18 |
| **Lodging** | CZ05 | 45.98 | 30.65 | 15.33 |
| **Lodging** | CZ06 | 40.35 | 26.90 | 13.45 |
| **Lodging** | CZ07 | 39.59 | 26.39 | 13.20 |
| **Lodging** | CZ08 | 38.44 | 25.63 | 12.81 |
| **Lodging** | CZ09 | 38.44 | 25.63 | 12.81 |
| **Schools** | CZ01 | 24.56 | 16.38 | 8.19 |
| **Schools** | CZ02 | 21.86 | 14.57 | 7.29 |
| **Schools** | CZ03 | 21.95 | 14.63 | 7.32 |
| **Schools** | CZ04 | 20.83 | 13.89 | 6.94 |
| **Schools** | CZ05 | 22.51 | 15.01 | 7.50 |
| **Schools** | CZ06 | 19.75 | 13.17 | 6.58 |
| **Schools** | CZ07 | 19.38 | 12.92 | 6.46 |
| **Schools** | CZ08 | 18.82 | 12.55 | 6.27 |
| **Schools** | CZ09 | 18.82 | 12.55 | 6.27 |

*\*See attachment B for both 1.5 gpm and 1.8 gpm gas savings in all climate zones\**

* 1. Commercial Building occupancy classifications

Due to the wide range of the calculated savings in hotels and schools, savings for three building types are listed in the “Energy Impacts” table within the EAD Access file. They are as follows:

* Lodging as Com Htl (for Hotels)
* Lodging as Com Mtl (for Motels)
* Commercial building types include the following:
  + Education- High School, College, University and University Dormitory
  + Fitness Center - Private Health Club
  + Health/Medical – Hospital, and Nursing Homes
  + Municipal - City Parks/Recreations, Swimming Pools

This workpaper includes the use of the COM building type. This building type designation covers, but is not limited to, the commercial building types listed above. The savings estimated within this workpaper include only educational and lodging facilities. Due to lack of sufficient data, the workpaper applies the educational facility savings to the COM building type.

# Section 3. Load Shapes

From the 2015 ASHRAE Application handbook, on Service Water Heating, the following graphs show the hourly hot water flow profiles for a hotel/motel and school buildings. The motels profile shows a peak demand from 6am to 8am, while the schools profile peaks during the afternoon and afterschool hours 4 to 6pm.

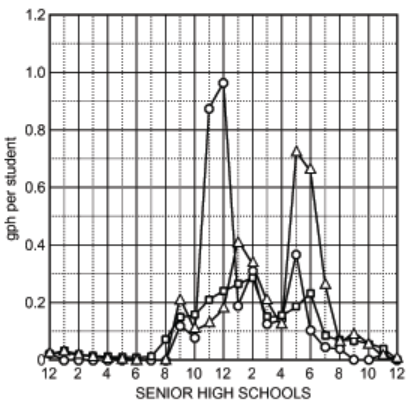
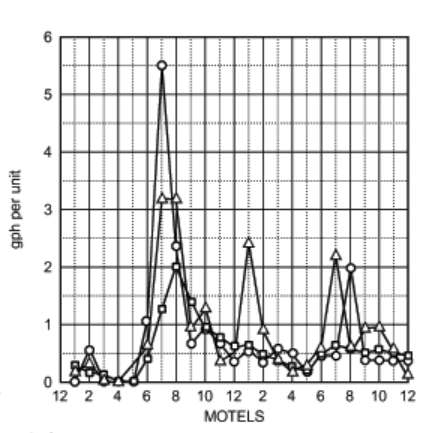


Figure : Service Water Heating, from ASHRAE application handbook

# Section 4. Costs

* 1. Base Case Cost

Revised DEER cost data for 2.5 GPM showerhead measure was used for installed base cost. The equipment/material cost per unit ($/unit) is $14.32, while the installation cost is $16.74 per unit. The total installed base cost per unit is $31.06. The base material cost and base labor cost for Early Retirement is $0.00.

* 1. Gross Measure Cost

Low flow showerheads will have the same cost as a 2.0 GPM showerhead cost in DEER2008. The DEER 2008 measure cost is $45.96, to replace greater than 2.5 GPM (~4-6 GPM) shower-heads with 2.0 GPM showerheads. The components of low flow showerhead fixtures are fundamentally the same, thus low flow showerheads will not incur any additional cost. In addition, installation costs will be the same for low flow showerheads, see *(Attachment D).*

The DEER equipment cost per unit ($/unit) is $29.22 for low flow showerheads, and the installation labor cost is $16.74. The total installed measure cost per unit is $45.96, same as the base cost.

For ER measures, a dual baseline is adopted. RUL will equal to . In the remaining useful life (RUL) of the measure, there will be no base total cost in upgrading from 2.25 GPM showerheads to less than 2.0 GPM showerheads. However, the base total cost will be $31.06 after the remaining useful life.

* 1. Full and Incremental Measure Cost

The incremental measure cost is the difference between the measure total cost and the base total cost. In ER programs, the base total cost is $0 in the first baseline (existing) and $31.06 in the second baseline (code); however, the measure total cost is $45.96 in the first baseline and $14.90 in the second baseline.

Table 6: Full and Incremental Measure Cost Equations

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| ER | (MEC + MLC) – (BEC + BLC) | MEC + MLC | (MEC + MLC) – (BEC + BLC) |

MEC = Measure Equipment Cost; MLC = Measure Labor Cost

BEC = Base Case Equipment Cost; BLC = Base Case Labor Cost

Table 17: Full and Incremental Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| ER | $45.96- $31.06 = $14.90 | $31.06 + $14.90 = $45.96 | $45.96- $31.06 = $14.90 |

# Attachments

Attachment A - CLEAResult Commercial Showerhead Study

Attachment B - Energy Savings Data and Calculations

Attachment C - Sample of Data Collected at Hotels

Attachment D - Commercial LFSH Summary Table

Attachment E – PKF Consulting: Southern California Lodging Forecast

**\*\*Files submitted separately. \*\***

# References

1. PKF Consulting USA, Oct 2015; Southern California Lodging Forecast. (*Attachment E)*

   <https://www.cpp.edu/~collins/partners/outlook-conference/documents/PKFConsulting.pdf> [↑](#endnote-ref-1)
2. Planning and Management Consultants, Ltd., Aquacraft, Inc., and John Olaf Nelson Water Resources Management. For the American Water Works Association. 2000. "Commercial and Institutional End Uses of Water".

   <http://www.waterrf.org/PublicReportLibrary/RFR90806_2000_241B.pdf> [↑](#endnote-ref-2)
3. Appendix D; Table D-7 Page 5; Gleick, P., Haasz, D., Henges-Jeck, C., Srinivasan, V., Wolff, G., Cushing, K. K., et al. (2003). Waste Not, Want Not: The Potential for Urban Water Conservation in California. Pacific Institute.

   <http://pacinst.org/app/uploads/2013/02/appendix_d3.pdf> [↑](#endnote-ref-3)
4. Table PBA1. COMMERCIAL BUILDINGS ENERGY CONSUMPTION SURVEY (CBECS); <http://www.eia.gov/consumption/commercial/data/2012/bc/cfm/pba1.php> [↑](#endnote-ref-4)