**Workpaper WPSCGNRWH121113A**

**Revision 4**

**Southern California Gas Company**

**Low-Flow Pre-Rinse Spray Valves**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Measure Codes** | **TBD** |
| **Measure Description** | Commercial Pre-Rinse Spray Valve (PRSV)   * 0.75 – 1.07 gpm flow rate   Commercial Pre-Rinse Spray Valve (PRSV)   * < 0.75 gpm flow rate |
| **Base Case Description** | DOE 2019 Minimum Federal Standard:   * 1.20 gpm flow rate |
| **Units** | Each |
| **Energy Savings** | Refer to Excel Calculation Attachment  Average Savings:   * PRSV = 0.75 – 1.07 gpm: 17.2 Therms/year * PRSV = <.75 gpm: 59.6 Therms/year |
| **Full Measure Cost ($/unit)** | PRSV = 0.75 – 1.07 gpm: $22 per unit  PRSV = <.75 gpm: $28 per unit |
| **Incremental Measure Cost ($/unit)** | For Normal Replacement measures, the FMC is equal to the IMC. |
| **Effective Useful Life** | Source: SBW (2007) Impact and Process Evaluation Final Report for the CUWCC Pre-Rinse Spray Valve Program (Phase II):  EUL ID: Cook-LowPreRinse = 5-year EUL |
| **Measure Installation Type** | New Construction (NC), Normal Replacement (NR) |
| **Net-to-Gross Ratio** | 0.6 (DEER NTGR ID: Com-Default>2yrs) |
| **Important Comments** | None |

# Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision No.** | **Date** | **Description** | **Author** |
| 0 | December 21, 2012 | Original release | Kyle Dunn (MWE2) |
| 1 | January 11, 2013 | Replaced description and savings for average qualifying PRSV of 1.11 GPM with separate descriptions and savings for 1.07 GPM and 1.15 GPM PRSVs | Kyle Dunn (MWE2) |
| 2 | June 16, 2014 | Added prescriptive rebate to the delivery method. Provided new cost data for the prescriptive rebate. | Joseph Pan (SCG) |
| 3 | July 30, 2014 | Removed 1.07 and 1.15 GPM measures. Added 1.28 GPM measure. | Joseph Pan (SCG) |
| 4 | December 6, 2018 | Revision to accommodate the 2019 DOE federal minimum standard. Separation of a single measure into two measures based on flow criteria:  <0.75 gpm and 0.75 – 1.07 gpm. | Denis Livchak (Frontier Energy) |

# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

This work paper details the purchase of new or replacement commercial low-flow pre-rinse spray valves (PRSV). This measure includes criteria for flow rate measured in gallons per minute (gpm) of low-flow pre-rinse spray valves divided into two qualification categories.

Base, Standard, and Measure Cases

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | Commercial Pre-Rinse Spray Valve (PRSV)   * 0.75 – 1.07 gpm flow rate   Commercial Pre-Rinse Spray Valve (PRSV)   * < 0.75 gpm flow rate |
| Existing Condition | N/A |
| Code/Standard | DOE 2019 Minimum Federal Standard:   * 1.20 gpm flow rate; > 5.0 oz. force * 1.00 gpm flow rate; 4.0 – 5.0 oz. force |
| Industry Standard Practice | N/A |

Measures and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
| TBD |  |  |  | Commercial Pre-Rinse Spray Valve (PRSV)   * 0.75 – 1.07 gpm flow rate |
| TBD | Commercial Pre-Rinse Spray Valve (PRSV)   * < 0.75 gpm flow rate |

\*Based on the ANSI/ASTM F2324-13[[1]](#endnote-2)

This measure includes new commercial pre-rinse spray valves that meet the minimum prescriptive criteria listed above. Used or rebuilt equipment is not eligible. Customers must provide proof that the appliance meets the qualification requirements.All non-residential building types are eligible. This measure is not approved for any residential building type. This measure is restricted to operations with natural gas water heaters only. Any climate zone is eligible including CZ01 through CZ16.

The low-flow pre-rinse spray valve measure is eligible as a downstream, midstream, or a direct-install measure. The downstream incentive is provided to the customer at the time of sale or after installation upon receipt of requisite documentation (customer location, application, invoice). The midstream offering offers an incentive to the contractor or distributor to promote the efficient measure.

This measure is applicable to any commercial foodservice application including (but not limited to) full-service and quick-service restaurants, hotels, motels, schools, colleges, cafeterias, healthcare, correctional facilities, military, and recreational facilities.

## 1.2 Technical Description

## Pre-rinse spray valves (PRSV), also referred to as spray nozzles or spray heads, are used in various food service applications such as restaurants and cafeterias to remove loose food and debris from plates and other dishware prior to loading in a dishwashing machine.

## ASTM F2324-13 is the current test method measuring both flow rate in gpm and spray force in ozf. There is a relationship between force and flow rate; the most efficient spray valves can deliver more force with less flow rate. As hot water is dispensed to the PRSV to rinse dishware more effectively, a reduction in flow rate results in energy and water savings.

The inclusion of the spray force test led to the separation of pre-rinse spray valves into two categories: units delivering less than 5 ozf and those delivering greater than 5 ozf. The maximum flow rate requirements depend on spray force. The 2019 Department of Energy (DOE) Federal Minimum Standard[[2]](#endnote-3) specifies a maximum flow rate of 1.00 gpm for spray valves delivering less than 5.0 ozf, 1.20 gpm for 5.0 – 8.0 ozf, and 1.28 gpm for more than 8.0 ozf. Spray valves under 4 ozf are considered ineffective for most commercial foodservice applications and valves over 8 ozf are considered too powerful for effective use in commercial foodservice dish washing applications. This work paper separates pre-rinse spray valves into two categories: units with spray force less than 5.0 ozf and those with spray force greater than 5.0 ozf.

For simplicity, this measure will require compliance with the above Federal Minimum Standard as a prerequisite, while measure criteria will be based exclusively on flow rate split into two categories: pre-rinse units with flow rates < 0.75 gpm and those with flow rates between 0.75 gpm – 1.07 gpm.

## 1.3 Installation Types and Delivery Mechanisms

Spray valves replaced through this rebate or direct install program are at the end of their effective useful life. As stated in the EM&V studies conducted on PRSVs, Pre-Rinse Spray Valve Programs: How Are They Really Doing?[[3]](#endnote-4), the effective useful life of PRSVs is five years. The last California Urban Water Conservation Council (CUWCC) Pre-Rinse Spray Head Distribution Program[[4]](#endnote-5) was completed in 2006 with many of those pre-rinse spray valves still installed in the field.

This measure focuses on NR and NC applications only.

Installation Type Descriptions

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Installation Type** | **Savings** | | **Life** | |
| 1st Baseline (BL) | 2nd BL | 1st BL | 2nd BL |
| Normal Replacement (NR) | Above Code or Standard | N/A | EUL | N/A |
| New Construction (NC) | Above Code or Standard | N/A | EUL | N/A |

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. The delivery method for the measure in this work paper is Financial Support – Direct Install Programs – Down-Stream Programs – Mid-Stream Programs.

Delivery Method Descriptions

|  |  |
| --- | --- |
| **Delivery Method** | **Description** |
| Financial Support | The program motivates customers, through financial incentives such as rebates or low interest loans, to implement energy efficient measures or projects. |

Incentive Method Descriptions

|  |  |
| --- | --- |
| **Incentive Method** | **Description** |
| Direct Install | The program implements energy efficiency measures for qualifying customers, at no cost to the customer. |
| Down-Stream Incentive | The customer installs qualifying energy efficient equipment and submits an incentive application to the utility program. Upon application approval, the utility program pays an incentive to the customer. Such an incentive may be deemed or customized. |
| Mid-Stream Incentive | The program gives a financial incentive to a midstream market actor, such as a retailer or contractor, to encourage the promotion of efficient measures. The incentive may or may not be passed on to the end-use customer. |

## 1.4 Measure Parameters

### 1.4.1 DEER Data

The 2018 DEER database[[5]](#endnote-6) does not contain information on energy use, savings, equipment costs, hours of operation, or effective useful life for a PRSV measure.

DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Used for Work Paper?** |
| 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 | DEER 2018, READI v2.4.8 |
| Reason for Deviation from DEER | DEER does not contain pre-rinse spray valve information |
| DEER Measure IDs Used | N/A |

**Net-to-Gross Ratio**

DEER 2018 does not specifically list commercial food service appliances. The default NTG values were obtained using the DEER READI tool6. The relevant NTG values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Measure Delivery** | **NTGR** |
| Com-Default>2yrs | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Com | Any | Any | 0.6 |
| Ind-Default>2yrs | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Ind | Any | All | 0.6 |
| Agric-Default>2yrs | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Ag | Any | All | 0.6 |

Note: Direct install measures that are not hard-to-reach will use the default NTG value.

**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**

DEER 2018 does not specifically list commercial food service appliances. The default 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.

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

**Effective and Remaining Useful Life**

DEER 2018 does not specifically list EUL for commercial food service appliances.

For pre-rinse spray valves, an EUL of 5 years was referenced from the 2007 impact and process evaluation of the California Urban Water Conservation Council 2004-5 Pre-Rinse Spray Valve Installation Program (Phase 2) study5.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **Use Category** | **EUL (Years)** | **RUL (Years)** |
| Cook-LowPreRinse | Commercial Low-Flow Pre-Rinse Spray Valves | Com | N/A | 5 | 1.66 |

### 1.4.2 Codes and Standards Analysis

This equipment base case falls under the 2019 Department of Energy (DOE) Federal Minimum Standard (10 CFR 431.263)3. Under this regulation, the following is required: ASTM Standard Test Method for the Performance of Pre-Rinse Spray Valves (F2324-131) for estimating the energy and water consumption and cleaning performance of the spray valve. DOE has determined that spray force is a performance-related feature that justifies different standard levels. Consequently, this final rule establishes three product classes based on spray force ranges:

2019 DOE Federal Minimum Standard for Commercial Pre-Rinse Spray Valves

|  |  |  |
| --- | --- | --- |
| **Product Class** | **Force Limitations** | **Maximum Flow Rate** |
| 1 | ≤ 5.0 ozf | 1.00 gpm |
| 2 | > 5.0 ozf and ≤ 8.0 ozf | 1.20 gpm |
| 3 | > 8.0 ozf | 1.28 gpm |

DOE market research indicates three distinct categories of end-user applications for commercial pre-rinse spray valves, which require distinct levels of spray force:

1. cleaning delicate glassware and removing loose food particles from dishware (requires the least amount of spray force)
2. cleaning wet foods
3. cleaning baked-on foods (requires the greatest amount of spray force)

**DOE Market Class Boundary Justification**

DOE selected 5.0 ozf as the spray force cut-off between product class 1 and product class 2 based on DOE test data and market research, which clearly showed a cluster of PRSV units above and below that threshold. One cluster of Commercial Prerinse Spray Valve (CPSV) units had spray force ranges between 4.1 and 4.8 ozf, while the other cluster was between 5.5 and 7.7 ozf. Additionally, in comments to the 2014 CPSV Framework3 document, T&S Brass suggested a flow rate cut-off of 0.80 gpm between the “ultra-low-flow” and “low-flow” commercial pre-rinse spray valves. A flow rate of 0.80 gpm equates to 5.3 ozf using the flow rate-spray force linear relationship determined by DOE. Based on these considerations, DOE established the threshold between the two classes at 5.0 ozf.

DOE selected 8.0 ozf as the spray force cut-off between product class 2 and product class 3 based on test results of commercial pre-rinse spray valves with shower-type spray shapes. Shower-type spray shapes provide the distinct utility of minimizing “splash back” which can be associated with nozzle-type designs at higher flow rates. In addition to the three clusters of data points in the flow rate-spray force plot, DOE testing showed that the upper range of the market, in terms of flow rate, predominantly includes shower-type units. DOE found that the lowest tested spray force of any shower-type unit was 8.1 ozf. Additionally, in comments to the 2014 CPSV Framework document, T&S Brass suggested a flow rate cut-off of 1.28 gpm between the “low-flow” and “standard” commercial pre-rinse spray valves. A flow rate of 1.28 gpm equates to 8.5 ozf using the flow rate-spray force linear relationship determined by DOE. Based on these considerations, DOE selected 8.0 ozf to differentiate product class 3 units from other commercial prerinse spray valves available on the market.

**DOE Market Threshold Level Justification**

DOE defined the market baseline for product classes 1 and 2 as the greater of (1) the highest flow rate in the class that meets the Federal standard, or (2) the flow rate at the upper spray force bound of the product class as predicted by the spray force-flow rate linear relationship described in chapter 5 of the technical support document. The most consumptive unit that was tested in product class 1 had a flow rate of 0.97 gpm, which exceeds the 0.75 gpm predicted by the linear relationship between spray force and flow rate for the product class 1 upper spray force bound of 5.0 ozf. DOE rounded the market baseline flow rate of product class 1 to 1.00 gpm. The market baseline for product class 2, predicted by the spray force-flow rate linear relationship, is 1.20 gpm at the upper spray force bound of 8.0 ozf. DOE did not find any commercial pre-rinse spray valves in product class 2 that exceed this flow rate. For product class 3, the market baseline equals the Federal flow rate standard of 1.60 gpm.

The analysis also identified the lowest flow rate that is commercially available within each product class (i.e., the max-tech model). DOE determined the max-tech level as the least consumptive tested commercial pre-rinse spray valve in each product class. The max-tech levels for product classes 1, 2, and 3 are 0.62, 0.73, and 1.13 gpm, respectively. Finally, DOE also defined intermediate efficiency levels between the baseline and max-tech levels for each product class. Further information about DOE’s efficiency level definitions is provided in chapter 5 of the final rule technical support document. The tables below provide the updated efficiency levels for all three product classes.

Pre-2019 DOE Efficiency Levels for Commercial Pre-Rinse Spray Valves ≤ 5.0 ozf

|  |  |  |
| --- | --- | --- |
| **Efficiency Level** | **Descriptions** | **Flow Rate (gpm)** |
| Baseline | Current Federal Standard | 1.60 |
| Level 1 | Market Minimum | 1.00 |
| Level 2 | 15% improvement over market minimum | 0.85 |
| Level 3 | 25% improvement over market minimum | 0.75 |
| Level 4 | Maximum technologically-feasible (max-tech) | 0.62 |

Pre-2019 DOE Efficiency Levels for Commercial Pre-Rinse Spray Valves > 5.0 and ≤ 8.0 ozf

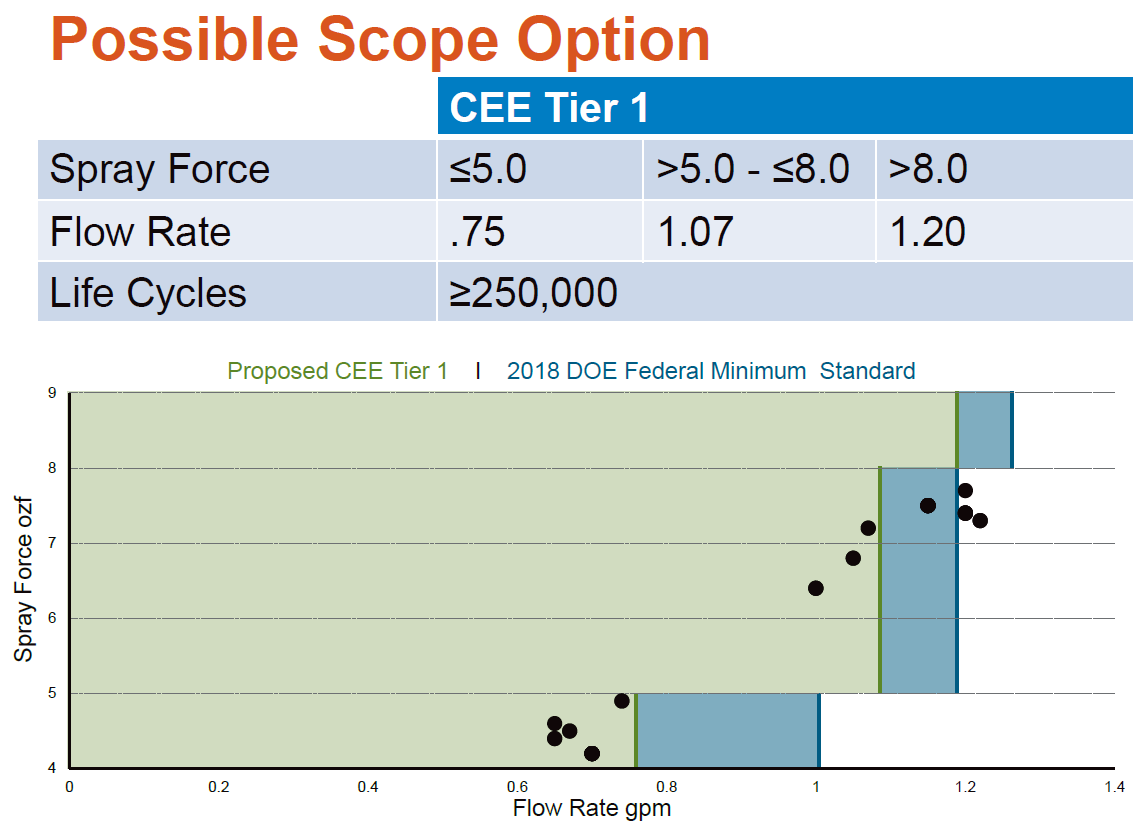
|  |  |  |
| --- | --- | --- |
| **Efficiency Level** | **Descriptions** | **Flow Rate (gpm)** |
| Baseline | Current Federal Standard | 1.60 |
| Level 1 | Market Minimum | 1.20 |
| Level 2 | 15% improvement over market minimum | 1.02 |
| Level 3 | 25% improvement over market minimum | 0.90 |
| Level 4 | Maximum technologically-feasible (max-tech) | 0.73 |

Pre-2019 DOE Efficiency Levels for Commercial Pre-Rinse Spray Valves > 8.0 ozf

|  |  |  |
| --- | --- | --- |
| **Efficiency Level** | **Descriptions** | **Flow Rate (gpm)** |
| Baseline | Current Federal Standard | 1.60 |
| Level 1 | 10% improvement over baseline | 1.44 |
| Level 2 | WaterSense level; 20% improvement over baseline | 1.28 |
| Level 3 | Maximum technologically feasible (max-tech) | 1.13 |

Consortium for Energy Efficiency (CEE) analysis of flow rate and spray force of 53 products from five spray valve manufacturers in June 2018[[6]](#endnote-7),8 within the three categories set by DOE resulted in new proposed water efficient thresholds.

CEE Market Analysis of Commercial Pre-Rinse Spray Valves7,[[7]](#endnote-8)



The proposed CEE thresholds reflected the market available models in each force category while exhibiting water savings over the DOE minimum levels.

2019 Proposed CEE Thresholds for Commercial Pre-Rinse Spray Valves

|  |  |  |
| --- | --- | --- |
| **Product Class** | **Force Limitations** | **Maximum Flow Rate** |
| 1 | ≤ 5.0 ozf | 0.75 gpm |
| 2 | > 5.0 ozf and ≤ 8.0 ozf | 1.07 gpm |
| 3 | > 8.0 ozf | 1.20 gpm |

Product class 3 with spray valve forces over 8 ozf was identified by DOE for cleaning dishware with baked-on debris. Cleaning of such items should be performed with a scraper or other mechanical methods instead of a water-intensive spray valve. For this reason, the proposed CEE flowrate threshold for that class of spray valve is not recommended. Therefore, any spray valve over 5 ozf should meet the 1.07 gpm requirement. Spray valves with less than 4 ozf do not provide adequate cleaning performance and will not be included in the proposed measure.

2019 Proposed Measure Thresholds for Commercial Pre-Rinse Spray Valves

|  |  |  |
| --- | --- | --- |
| **Product Class** | **Force Limitations** | **Maximum Flow Rate** |
| 1 | 4.0 – 5.0 ozf | 0.75 gpm |
| 2 | > 5.0 ozf and ≤ 8.0 ozf | 1.07 gpm |
| 3 | > 8.0 ozf |

This equipment’s measure case is based on a 11-25% reduction in flow rate compared to the Federal standard. The measure cases for this work paper will have flow rates shown in the table above.

Proposed Measure Standard vs Federal Minimum Standard

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Product Class** | **Force Limitations** | **DOE 2019 Maximum Flow Rate** | **Measure Maximum Flow Rate** | **Measure Flow Rate Reduction** |
| 1 | ≤ 5.0 ozf | 1.00 gpm | 0.75 gpm | 25% |
| 2 | > 5.0 ozf and ≤ 8.0 ozf | 1.20 gpm | 1.07 gpm | 11% |
| 3 | > 8.0 ozf | 1.28 gpm | 1.07 gpm | 16% |

***Title 24:***

This measure does not fall under Title 24 of the California Energy Regulations.

***Title 20:***

This measure falls under Title 20[[8]](#endnote-9) of the California Public Utility Commission (CPUC) Energy Regulations. State regulations must follow federal regulations, so Title 20 regulation will be aligned with the DOE minimum federal standard.

Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 24 (2019) | N/A | N/A |
| Title 20 (2019) | Will align with U.S. DOE 10 CFR 431.263 | January 28, 2019 |
| U.S. DOE Code of Federal Regulations | 10 CFR 431.263 | January 28, 2019 |

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

Pre-rinse spray valves have been included as part of energy efficiency programs in California, Washington, and Canadian cities for several years. These programs have undergone evaluation studies validating the effectiveness of high-efficiency spray valves and their operational characteristics. Two separate studies conducted by Tso, Koeller, and SBW Consulting document the baseline operating hours, baseline flow rates, proposed operating hours, proposed flow rates, mixed water temperature, and supply water temperature for spray valves. The results of these studies are used as the basis for energy savings calculations for this measure.

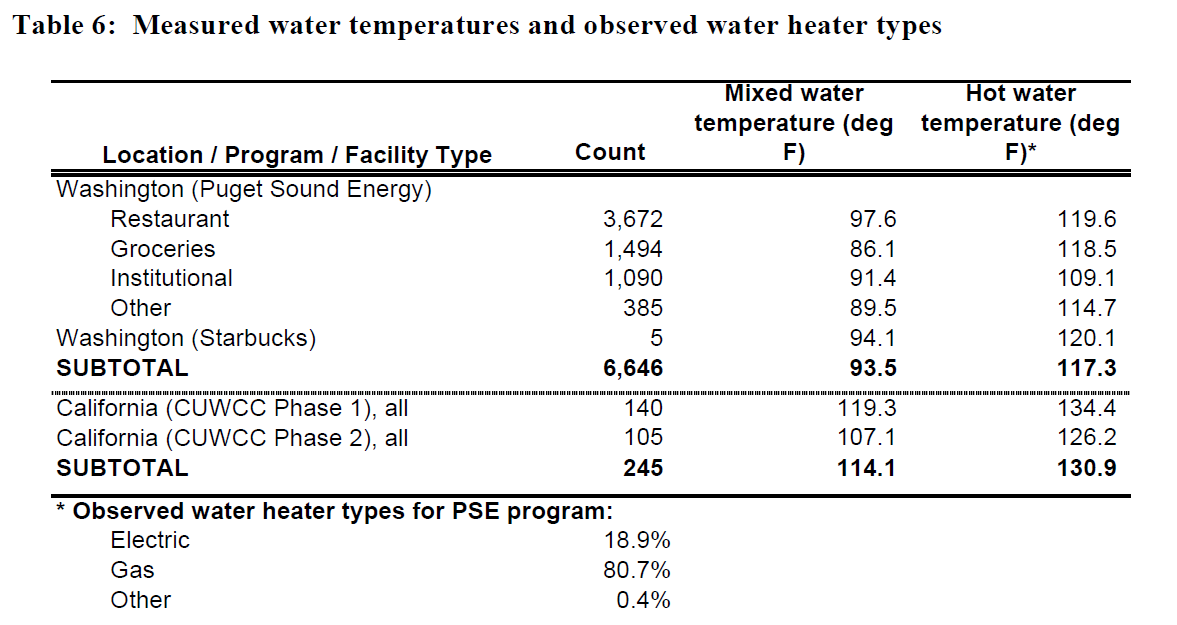
### 1.5.1 Pre-Rinse Spray Valve Programs: How Are They Really Doing?4

The study in 2005 by Bing Tso and John Koeller randomly selected 16 different commercial foodservice sites out of 17,000 spray valve installation sites for monitoring and verification studies. All sites were locations where a high-flow PRSV was initially measured for flow rate, hours of operation, and mixed water temperature. Subsequently, the sites were monitored with a low-flow pre-rinse spray valve. The study was conducted in foodservice facilities throughout California, Washington, and Canada over the course of two years from 2003 to 2005. The research was conducted through a combination of equipment monitoring and surveys and used to evaluate the baseline operating hours, baseline flow rates, proposed operating hours, proposed flow rates, mixed water temperature, and supply water temperature for each of the facilities.

***Energy Savings Calculation Assumptions:***

Mixed water temperatures for foodservice establishments averaged 114.1°F during the monitoring period as a combination of two studies (in section 1.5.2 and 1.5.3) for a total of 245 sites.

Measured Water Temperatures for Foodservice Establishments



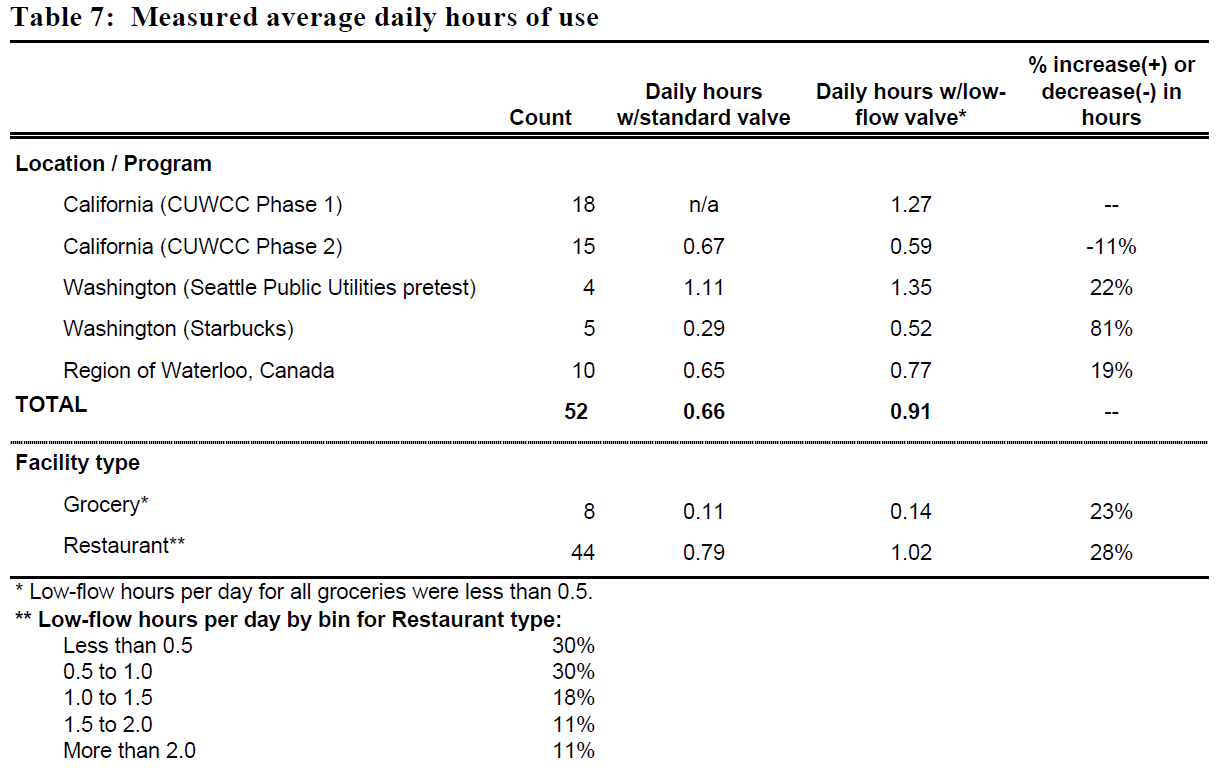
***Hours of Operation****:*

The baseline operating hours were determined using the results of existing evaluation studies for restaurant facilities that included baseline operating hours of 0.79 hours/day for a 2.92 gpm unit and the proposed operating hours of 1.02 hours/day for a 1.18 gpm unit. The linear relationship between these two parameters yielded an equation that was utilized to calculate operating hours for the baseline unit at 1.40 gpm. The equation is as follows:

Hours/day = -0.1322 x Flow Rate + 1.176

The measure hours of operation are consistent with the results of evaluation studies for previously implemented pre-rinse spray valve programs.

Measured Pre-Rinse Spray Valve Hours of Daily Use



**Base and Measure Case Operating Hours**

|  |  |  |
| --- | --- | --- |
| **Equipment Type** | **Rated Flow (gpm)** | **Operating Hours (h/day)** |
| Base Case | 1.40 | 0.991 |
| Measure Case | 1.07 | 1.034 |
| Difference |  | 0.043 |

Using the formula provided in the study documented below, the difference in the hours of operation between the base and measure case is 0.043 hours per day (4%) and is assumed to be negligent for this work paper. Therefore, it is assumed that the operating hours of spray valves at or below 1.4 gpm is 1.00 hour per day.

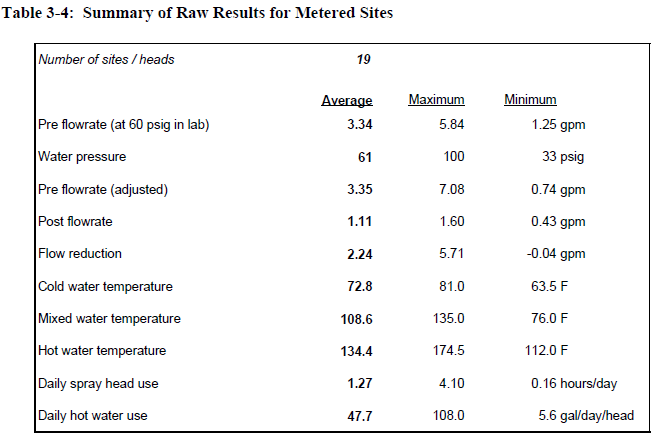
### 1.5.2 SBW (2004) Evaluation, Measurement & Verification Report for the CUWCC Pre-Rinse Spray Head Distribution Program[[9]](#endnote-10)

This study is an EM&V study conducted by SBW Consulting to document the findings and results of the second phase of the CUWCC Spray Valve Program. The research was conducted through a combination of equipment monitoring and surveys and used to evaluate the baseline operating hours, baseline flow rates, proposed operating hours, proposed flow rates, mixed water temperature, and supply water temperature for each of the facilities and was submitted to the CPUC. The EM&V study documented 140 different spray valve installations with 19 of the installations monitored for flow rate and temperature for at least one month.

***Energy Savings Calculation Assumptions:***

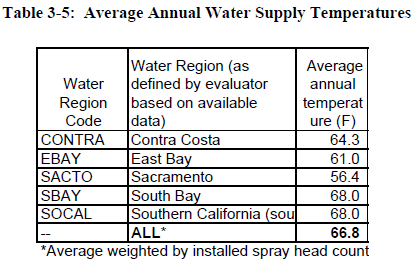
This study documented the average PRSV outlet temperature to be 108.6°F and rinse time to be 1.27 hours per day (Section 3.3.1) based on 19 data points.

Summary of Results from Metered Sites



This study documented the average supply temperature to be 66.8°F (Section 3.3.4) based on information from 5 largest California water providers.

Average Annual Water Supply Temperatures



### 1.5.3 SBW (2007) Impact and Process Evaluation Final Report for the CUWCC Pre-Rinse Spray Valve Program (Phase 2)5

This study is an EM&V study conducted by SBW Consulting to document the findings and results of the second phase of the CUWCC Spray Valve Program. The research was conducted through a combination of equipment monitoring and surveys and used to evaluate the baseline operating hours, baseline flow rates, proposed operating hours, proposed flow rates, mixed water temperature, and supply water temperature for each of the facilities and was submitted to the CPUC. The EM&V study documented 195 different spray valve installations with 29 of the installations monitored for flow rate and temperature for at least one month.

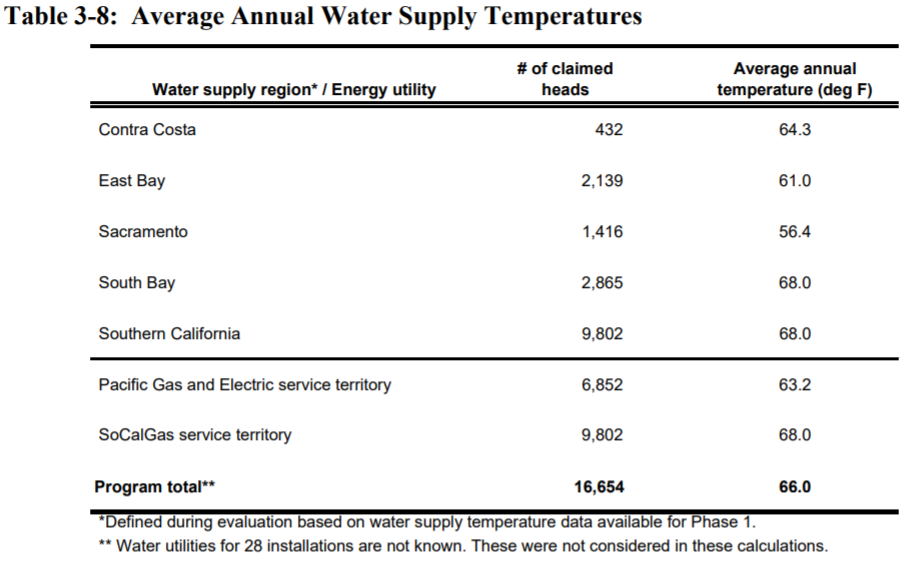
***Effective Useful Life:***

For pre-rinse spray valves, the 5-year EUL is taken from the 2007 impact and process evaluation of the California Urban Water Conservation Council 2004-5 Pre-Rinse Spray Valve Installation Program (Phase 2) study.

***Energy Savings Calculation Assumptions:***

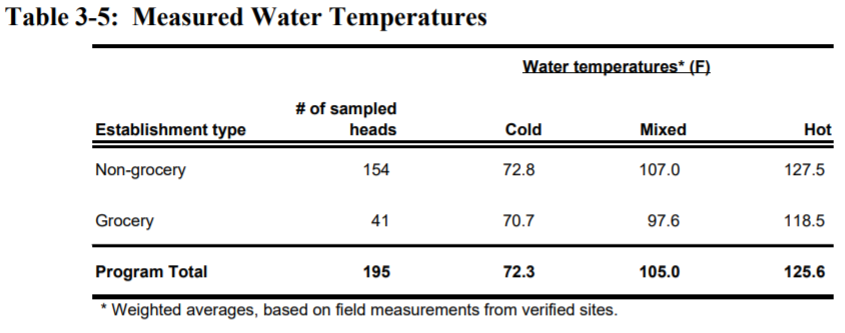
This study documented the average supply temperature to be 66.0°F (Section 3.4.5) based on 16,654 data points.

California Average Annual Water Supply Temperatures



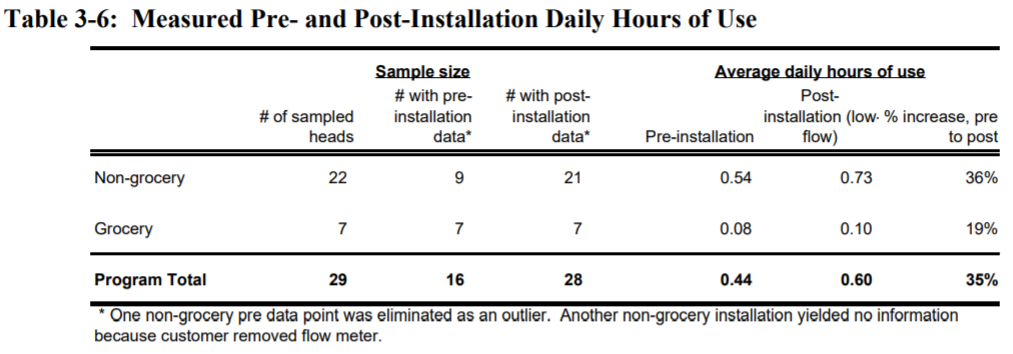
This study documented the average PRSV mixed outlet temperature to be 105.0°F(Section 3.4.2) based on 29 data points.

Measured Water Temperatures for Foodservice



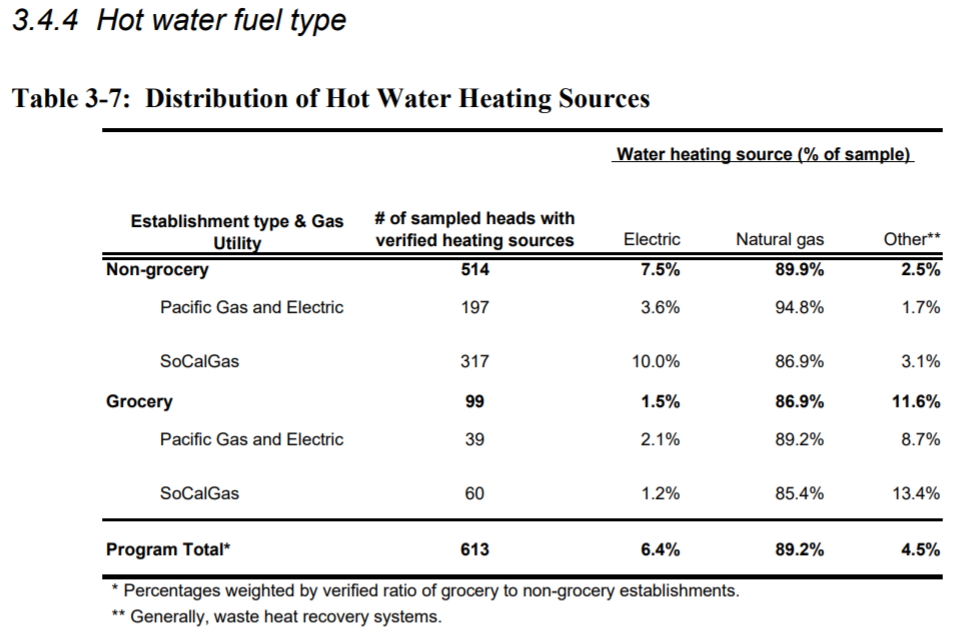
This study documented the average rinse time using sub-metered flow rate data to be 0.44 hours per day for 29 sites (Section 3.4.3).

Measured Pre- and Post-Installation Daily Hours of Use



This study documented the gas to electric water heating ratio to be 93%/7% based on 613 sites excluding other fuel sources (Section 3.4.4).

California Distribution of Hot Water Heating Sources



### 1.5.4 CEC Energy Efficiency Potential of Gas Fired Commercial Water Heating Equipment in Foodservice Facilities, 2010, CEC-500-2013-050[[10]](#endnote-11)

This study provided market data on gas water heaters in different commercial and institutional foodservice facilities in each market segment with an 88%/12%split between gas and electric water heaters based on 96,860 sites.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Facility Type** | **Number of Facilities** | **% Gas** | **% Electric** | **Number of Gas Heaters** | **Number of Electric Heaters** |
| Full-Service Restaurant | 34,400 | 90 | 10 | 30,960 | 3,440 |
| Quick-Service Restaurant | 21,700 | 90 | 10 | 19,530 | 2,170 |
| Coffee and Specialty | 11,800 | 80 | 20 | 9,440 | 2,360 |
| Bar and Tavern | 3,350 | 75 | 25 | 2,513 | 838 |
| Deli and Sandwich | 5,500 | 75 | 25 | 4,125 | 1,375 |
| Correctional | 45 | 100 | 0 | 45 | - |
| College and University | 445 | 100 | 0 | 445 | - |
| Hospital | 440 | 100 | 0 | 440 | - |
| Hotel and Casino | 1,340 | 100 | 0 | 1,340 | - |
| Work Cafeteria | 810 | 95 | 5 | 770 | 41 |
| Supermarket | 2,240 | 90 | 10 | 2,016 | 224 |
| K-12 School | 9,460 | 95 | 5 | 8,987 | 473 |
| Military Base | 210 | 95 | 5 | 200 | 11 |
| Nursing Home | 1,340 | 90 | 10 | 1,206 | 134 |
| Miscellaneous | 1,740 | 95 | 5 | 1,653 | 87 |
| Independent and Assisted Living | 2,040 | 90 | 10 | 1,836 | 204 |
| **Total** | **96,860** |  |  | **85,505** | **11,356** |
| **Percentage** |  |  |  | **88.3%** | **11.7%** |

The study was conducted in 2010 and provides a more comprehensive market segment analysis than SBW (2007) Impact and Process Evaluation Final Report for the CUWCC Pre-Rinse Spray Valve Program (Phase II) study5. This study includes several commercial and institutional market segments beyond grocery and non-grocery and will be used in the calculation methodology in Section 2.

### 1.5.5 MWD Pre-Rinse Operation Field Study 2018[[11]](#endnote-12)

This study provided data on pre-rinse operations (PRO) in commercial kitchens. The study focused on larger PROs in corporate and university cafeterias with conveyor dishwashing machines. Out of 16 total sites, PRSVs were sub metered at six sites showing an average of 1.55 operating hours per day. Assuming larger facilities operate their PRSV longer, this hourly usage is in line with the 1.0 hour per day assumptions in 1.5.1, which includes smaller facilities.

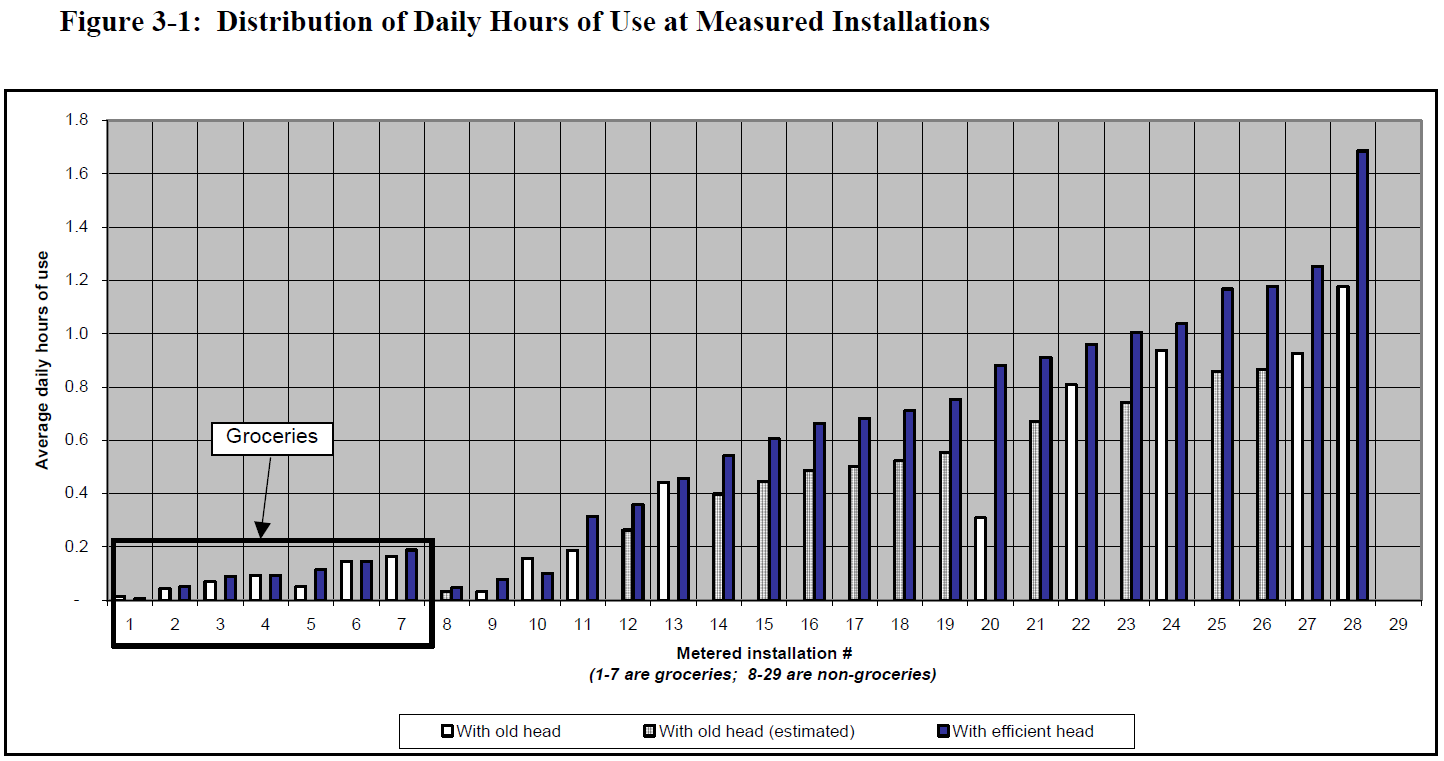
|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Facility** | **PRO Method** | **PRSV Hot (gal/d)** | **PRSV Cold (gal/d)** | **PRO Hot (gal/d)** | **PRO Cold (gal/d)** | **Total PRO (gal/d)** | **Hot Water** | **Hours of PRSV Operation (h/d)** |
| Corporate Café 1 | Dry Scrapping with PRSV | 90 | 9 | 90 | 9 | 99 | 91% | **1.43** |
| University Cafeteria #6 | Trough Feed Disposer with PRSV | 16 | 4 | 16 | 34 | 50 | 31% | **0.32** |
| University Cafeteria #3 | Dry Scrapping with PRSV | 41 | 3 | 89 | 3 | 92 | 97% | **0.92** |
| University Cafeteria #5 | Trough Feed Collector with PRSV | 118 | 3 | 418 | 3 | 421 | 99% | **1.74** |
| University Cafeteria #9 | Scrap Collector with PRSV | 119 | 8 | 123 | 19 | 142 | 87% | **2.73** |
| University Cafeteria #4 | Trough Feed Collector with PRSV | 51 | 27 | 821 | 852 | 1673 | 49% | **1.21** |
| Corporate Café 4 #8 | Trough Feed Pulper with 2 PRSVs | 315 | 14 | 1106 | 84 | 1190 | 93% | **2.52** |
|  | **Overall Average** | **107** | **10** | **380** | **143** | **524** | **78%** | **1.55** |

## 1.6 Data Quality and Future Data Needs

Referenced data in this work paper is 12 years old and should be updated. No specific PRSV study has been conducted since. The key values that affect this work paper are:

* Incoming water temperature – this value should not change over time and is well documented by water utilities; no update is needed.
* PRSV mixed temperature – this value should not change over time; the reference of 114.1°F is based primarily on the study mentioned in section 1.5.1, which accounts for 245 data points.
* PRSV on-time – this value may change as end-users switch to lower flow spray valves; this value is also dependent on facility size. The current reference of 1.0 hour is based primarily on the referenced study in 1.5.1; however, the hours of operation between sites varied greatly. It is recommended that more sites be monitored to substantiate that value.

Average Pre-Rinse Operation Daily Hours of Use5



* EUL – The EUL of 5 years is based on Phase 2 of the California study (1.5.3). EUL values are very difficult to determine and are mostly based on operator feedback. This value should be further substantiated by administering more surveys to manufacturers and end-users.
* Water Heater Efficiency – water heater efficiency is well documented based on laboratory testing; however, it will change as new water heaters become more efficient. Water heating efficiency referenced in this work paper is delivery efficiency to the PRSV, which is lower than efficiency of the water heater. This considers heating line losses between the water heater and the PRSV itself, which may be several feet of piping away from the heater. Different facility types will have different hot water recirculation systems and piping insulations that will affect PRSV water heating deliver efficiency. This efficiency was documented in the CEC *Demonstration of High-Efficiency Hot Water Systems in Commercial Foodservice* to be published in 2019, however, that study encompasses only two sites and more references are needed.
* Percentage of gas vs electric water heaters – this value varies by source type from 98%/2%[[12]](#endnote-13) to 88%/12%11 gas to electric for California. Electric water heaters are less common; however, they exist in smaller applications in non-stand-alone restaurants and cafes. Almost all large facilities in California use gas water heating. It is estimated that the 98% gas to 2% electric water heating split is based on total volume of water heated in the state; however, the number of electric water heaters may exceed 10%. A comprehensive statewide study needs to be conducted to substantiate these values.

# Section 2. Calculation Methodology

Commercial pre-rinse spray valves are designed to deliver 120-140°F water for cleaning at a certain flow rate expressed in gallons per minute. Spray valve water use has a direct impact on a building’s water heating system energy consumption.

* + 1. Energy Savings Calculation
       1. The annual energy use was calculated using the following equation:

*Eqn-1*

Where

* + - * 1. *F* – flow rate (gallons/min)
        2. density of water is 8.33 (lbm/gal)
        3. specific heat of water is 1.0 (btu/lbm-°F)
        4. temperature of mixed water (°F)
        5. temperature of supply water (°F)
        6. – daily operating hours (hours/day)
        7. – yearly days of operation (days/year)
        8. − thermal efficiency of natural gas water heating unit
      1. For calculating energy savings, the following assumptions are used:
         1. The average efficiency for the water heating unit equal to those from several evaluation studies, and is 70%.4,7
         2. The number of annual operating days is equal to the results from previous evaluation studies of installed PRSV units in California and is 365 days per year.4
      2. Given the above assumptions, the energy saved by installing a qualified pre-rinse spray valve is calculated as follows:

*Eqn-2*

* + 1. Water Savings Calculation
       1. The annual water use was calculated using hot, cold, and mixed water temperatures, using the following equation:

*Eqn-3*

Where

* + - * 1. *F* – flow rate (gallons/minute)
        2. – daily operating hours (hours/day)
        3. – yearly days of operating (days/year)
        4. – annual water use (gallons/year)
      1. The water saved by installing a qualified pre-rinse spray valve is calculated as follows:

*Eqn-4*

The table below shows energy and water savings for measure commercial pre-rinse spray valves for two categories based on force. This is an example calculation using an average state groundwater temperature of 63.3°F. More specific summary results will be shown in the subsequent table based on individual climate zone with varying groundwater temperatures. Water savings will the same for each climate zone and fuel type. 5-8 oz force federal threshold of 1.2 gpm is used as a baseline for both measure energy savings calculations because it is standard industry practice.

**Base and Measure Case Gas Energy and Water Savings**

|  |  |  |  |
| --- | --- | --- | --- |
| **Case** | **Baseline** | **Measure** | **Measure** |
| Force Category (ozf) | all | <5 | 5+ |
| **Flow Rate (gpm)** | **1.20** | **0.75** | **1.07** |
| Operating Hours per Day (h/day) | 1 | | |
| Daily Water Use (gal/day) | 72.0 | 45.0 | 64.2 |
| Operating Days per Year (days/yr) | 365 | | |
| Temperature Mixed H2O (°F) | 114.1 | | |
| Temperature Supply H20 (°F) | 63.3 | | |
| Temperature Rise in Water Heater (°F) | 50.8 | | |
| Water Heater Efficiency | 0.7 | | |
| Annual Energy Use (Therms/yr) | 158.9 | 99.3 | 141.7 |
| **Annual Energy Savings (Therms/yr)** | **-** | **59.6** | **17.2** |
| Annual Water Use (gal/yr) | 26,280 | 16,425 | 23,433 |
| Annual Water Use (CCF/yr) | 35.13 | 21.96 | 31.33 |
| **Annual Water Savings (CCF/yr)** | **-** | **13.18** | **3.81** |

\*1 CCF=748 gal; 1 therm=100,000 Btu; 1 gal = 8.33 lb; 1 Btu = 1 lb/lbm/°F

Groundwater temperatures referenced in the Energy Efficient Door-Type Commercial Dishwashers work paper[[13]](#endnote-14) will be used to calculate water heating energy consumption of PRSVs in different climate zones. The PRSV final mixed water temperature is still assumed to be 114.1°F for all climate zones.

**Base and Measure Case Gas Energy Savings for Different Climate Zones**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Utility** | **Climate Zone** | **Avg Groundwater Temperature (°F)** | **Annual Energy Savings (Therms/yr) 4.0 – 5.0 ozf; <=0.75 gpm** | **Annual Energy Savings (Therms/yr) > 5.0 ozf; 0.75 – 1.07 gpm** |
| PG&E | CZ01 | 51.4 | 64.7 | 18.7 |
| PG&E | CZ02 | 57.3 | 58.6 | 16.9 |
| PG&E | CZ03 | 57.1 | 58.8 | 17.0 |
| PG&E/SoCalGas | CZ04 | 59.5 | 56.3 | 16.3 |
| PG&E/SoCalGas | CZ05 | 55.8 | 60.2 | 17.4 |
| SoCalGas/SDG&E/SCE | CZ06 | 61.8 | 54.0 | 15.6 |
| SoCalGas/SDG&E | CZ07 | 62.6 | 53.1 | 15.4 |
| SoCalGas/SDG&E/SCE | CZ08 | 63.7 | 52.0 | 15.0 |
| SoCalGas/SCE | CZ09 | 63.8 | 51.9 | 15.0 |
| SoCalGas/SDG&E/SCE | CZ10 | 64.1 | 51.6 | 14.9 |
| PG&E | CZ11 | 63.2 | 52.5 | 15.2 |
| PG&E | CZ12 | 60.9 | 54.9 | 15.9 |
| PG&E/SoCalGas/SCE | CZ13 | 64.1 | 51.6 | 14.9 |
| SoCalGas/SCE | CZ14 | 62.7 | 53.0 | 15.3 |
| SoCalGas/SCE | CZ15 | 75.5 | 39.8 | 11.5 |
| PG&E/SoCalGas/SCE | CZ16 | 51.8 | 64.3 | 18.6 |
| **PG&E** |  | **57.9** | 58.0 | 16.8 |
| **SoCalGas** |  | **62.3** | 53.5 | 15.4 |
| **SDG&E** |  | **63.0** | 52.7 | 15.2 |
| **SCE** |  | **63.4** | 52.3 | 15.1 |
| **Average of all Climate Zones** |  | **60.9** | 54.9 | 15.9 |

Pre-rinse spray valves are not documented in the READI tool. Low-flow pre-rinse spray valves use results in gas water heater savings, so electric demand reduction is not applicable. Demand reduction estimates must consider the DEER peak demand period, which is 2:00 PM to 5:00 PM during specific weekday periods and varies by climate zone:

|  |  |
| --- | --- |
| **Climate Zone** | **3-Weekday Period** |
| 1 | Sep 16 – Sep 18 |
| 2 | July 8 – July 10 |
| 3 | July 8 – July 10 |
| 4 | Sep 1 – Sep 3 |
| 5 | Sep 8 – Sep 10 |
| 6 | Sep 1 – Sep 3 |
| 7 | Sep 1 – Sep 3 |
| 8 | Sep 1 – Sep 3 |
| 9 | Sep 1 – Sep 3 |
| 10 | Sep 1 – Sep 3 |
| 11 | July 8 – July 10 |
| 12 | July 8 – July 10 |
| 13 | July 8 – July 10 |
| 14 | Aug 26 – Aug 28 |
| 15 | Aug 25 – Aug 27 |
| 16 | July 8 – July 10 |

# Section 3. Load Shapes

The closest load shape chosen for this measure is the DEER: Indoor\_Non-CFL\_Ltg load shape. The base case load shape would be expected to follow a typical nonresidential foodservice end use load shape.

Commercial pre-rinse spray valve load shapes vary depending on facility type (quick-service, casual dining, hotels, college, schools, hospitals, etc.), hours of operation, serving periods, day-of-the-week, and facility location (urban downtown, suburban mall, access to interstate highways, etc.). Consequently, applicable average Time-of-Use (TOU) and hourly load shapes for PRSVs are unavailable. Generally, PRSVs are used to clean dishes after tables have been bussed, so loads tend to increase after regular meal periods (breakfast, lunch, and dinner).

There are no measure case load shapes applicable to these measures. The base case shapes and measure load shapes are identical.

The ideal load shape for net benefits estimates would represent the difference between the base case and measure case. The closest load shapes that are applicable to the measures in this work paper are listed in the table below.

Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **Load Shape** | **E3 Alternate Building Type** |
| Restaurant – Fast Food | SCG:NON\_RES:DEER:Com:Indoor\_CFL\_Ltg | NON\_RES |

# Section 4. Costs

Generally, high-efficiency low-flow pre-rinse spray valves are listed at a higher cost than standard PRSVs. Equipment prices for this work paper were compiled from online retailers selling PRSVs.

## 4.1 Base Case Cost

The base case costs include only the equipment. High-efficiency PRSVs require no additional labor or maintenance compared to base case PRSVs. Since this measure is applicable for NR and NC installations, the installation and maintenance costs are expected to be the same for the customer. The estimated equipment cost is based on recent list cost data for PRSVs from major online retailers. Base cost was determined for federally regulated spray valves between 1.07 and 1.20 gpm because higher flow PRSVs are standard practice. More detailed pricing information can be found in Appendix A.

The following measure application types are appropriate to these measures. The base case costs are:

**Base Case Costs**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Measure** | **Measure Application Type** | **Baseline** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Base Case Cost** |
| PRSV: < 0.75 gpm | NR /NC | Code/Standard | $46 | $0 | $0 | $46 |
| PRSV: 0.75 – 1.07 gpm | NR /NC | Code/Standard | $46 | $0 | $0 | $46 |

*All costs are noted as $ per measure unit*

## 4.2 Measure Case Cost

The measure costs include only the equipment, as explained in section 4.1. The estimated equipment cost is based on recent list cost data for PRSVs from major online retailers in September 2018. The following Measure Application Types are appropriate to these measures. The Measure Case Costs are:

**Measure Case Costs**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Measure*** | **Measure Application Type** | **Baseline** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Measure Case Cost** |
| PRSV: < 0.75 gpm | NR /NC | Code/Standard | $68 | $0 | $0 | $68 |
| PRSV: 0.75 – 1.07 gpm | NR /NC | Code/Standard | $74 | $0 | $0 | $74 |

*All costs are noted as $ per measure unit*

## 4.3 Full and Incremental Measure Cost

Full measure cost is the cost to install an energy-efficient measure per the California Public Utility Commission (CPUC) calculators. This definition implies a different meaning depending on the measure application type.

**Full and Incremental Measure Cost Equations**

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| NR/NC | (MEC + MLC) – (BEC + BLC) | (MEC + MLC) – (BEC + BLC) | N/A |
| NC/NC |

MEC = Measure Equipment Cost; MLC = Measure Labor Cost; BEC = Base Case Equipment Cost; BLC = Base Case Labor Cost

*\*Note: Various complicated price fluctuations are not addressed in these equations, such as future costs due to inflation in labor, future costs due to deflation in material cost, and other variables that cannot be accurately described at this time.*

Incremental measure cost (IMC) is the premium cost to install an energy-efficient measure over a standard-efficiency measure or code baseline measure. While IMC has a straightforward definition depending on the measure application type, the equation does vary. Incremental measure costs are used in the analysis.

**Full and Incremental Costs <=0.75gpm**

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| NR/NC | $22 | $22 | N/A |

**Full and Incremental Costs <=1.07gpm**

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| NR/NC | $28 | $28 | N/A |

# Attachments

Attachment A: Savings Calculations and Measure Summary

# Appendix A

Generally, high-efficiency low-flow pre-rinse spray valves are listed at a higher cost than standard PRSVs. Equipment prices for these work papers were compiled in September 2018 from online retailers selling PRSVs with most of the pricing data came from WebstaurantStore[[14]](#endnote-15), which is the largest online foodservice equipment retailer. Pricing for baseline models for the 4.0 – 5.0 ozf category was not available at the time of data collection, so the IMC for the >5.0 ozf category was applied to the 4.0 – 5.0 ozf category to get baseline cost. All valves selected for analysis meet the DOE 1.20gpm threshold.

**Equipment Cost Data for Pre-Rinse Spray Valves 4.0 – 5.0 ozf; <0.75gpm**

| **Group** | **Spray Force (ounces)** | **Maximum Rated Flow Rate (gpm)** | **Make** | **Model** | **Cost ($)** |
| --- | --- | --- | --- | --- | --- |
| Energy Efficient | 4.2 | 0.7 | Fisher | 10197 | $72.99 |
| Energy Efficient | 4.2 | 0.7 | Fisher | 13641 | $43.99 |
| Energy Efficient | 4.4 | 0.65 | T&S Brass | B-0107-C | $49.99 |
| Energy Efficient | 4.4 | 0.65 | T&S Brass | EB-0107-C | $58.99 |
| Energy Efficient | 4.6 | 0.65 | T&S Brass | B-0108-C | $69.99 |
| Energy Efficient | 4.9 | 0.74 | Encore Series | KLP50-0220-74 | $113.85 |

**Equipment Cost Data for Pre-Rinse Spray Valves >5.0 ozf; >0.75gpm**

| **Group** | **Spray Force (ounces)** | **Maximum Rated Flow Rate (gpm)** | **Make** | **Model** | **Cost ($)** |
| --- | --- | --- | --- | --- | --- |
| Baseline | 7.5 | 1.15 | Fisher | 2949 | $41.99 |
| Baseline | 7.5 | 1.15 | Fisher | 2949R | $41.99 |
| Baseline | 7.5 | 1.15 | Fisher | 71307 | $61.99 |
| Baseline | 7.7 | 1.2 | T&S Brass | 5SV-C | $38.49 |
| Energy Efficient | 6.4 | 1.0 | Chicago Faucet | 90-ANGABCP | $76.38 |
| Energy Efficient | 6.4 | 1.0 | Chicago Faucet | 90-LABCP | $49.93 |
| Energy Efficient | 6.8 | 1.05 | Encore Series | KLP50-Y002105 | $97.81 |
| Energy Efficient | 6.8 | 1.05 | Encore Series | KLP50-0220105 | $113.85 |
| Energy Efficient | 7.2 | 1.07 | T&S Brass | B-0107-J | $47.52 |
| Energy Efficient | 7.2 | 1.07 | T&S Brass | EB-0107-J | $58.99 |

**Equipment Incremental Cost Data for Efficient Pre-Rinse Spray Valves**

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Baseline Unit Cost** | **Energy Efficient Unit Cost** | **Incremental Measure Cost (IMC)** |
| Pre-Rinse Spray Valve <0.75gpm | $ 46 | $ 68 | $ 22 |
| Pre-Rinse Spray Valve >0.75gpm | $ 74 | $ 28 |

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