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FOOD SERVICE

LOW-FLOW PRE-RINSE SPRAY VALVE

SWFS013-01

CONTENTS

MEASURE NAME

Low-Flow Pre-Rinse Spray Valve

STATEWIDE MEASURE ID

SWFS013-01

TECHNOLOGY SUMMARY

Pre-rinse spray valves (PRSV), also referred to as spray nozzles or spray heads, are used in various food service applications to remove loose food and debris from plates and other dishes prior to loading them in a dishwasher. According to the U.S. Environmental Protection Agency (U.S. EPA), PRSVs can account for nearly one-third of the water used in a typical commercial kitchen.[1] Water flow rates of PRSVs range from 0.65 gallons per minute (gpm) to 4.50 gpm.

A *low-flow* pre-rinse spray valve utilizes a knife-edge spray rather than a shower-type spray to better focus the available energy and remove food debris more efficiently, while using less hot water. Because hot water is dispensed at the PRSV to rinse the plates more effectively, the reduction in the flow results in energy savings.

PRSV performance is quantified using the American Society for Testing and Materials (ASTM) Standard Test Method for Performance of Pre-Rinse Spray Valves (F2324).[2] Performance is measured by "cleanability," or the time it takes for the PRSV to rinse tomato paste from a plate.

MEASURE CASE DESCRIPTION

The measure case for the low-flow pre-rinse spray valve (PRSV) is defined by rated flow rate in gallons per minute (gpm):

- Low-flow PRSV with 0.75 gpm to 1.07 gpm
- Low-flow PRSV with < 0.75 gpm

The maximum flow rate requirements depend on the spray force rating (ounce-force, ozf). Spray valves with < 4 ozf are considered to be ineffective for most commercial foodservice applications and those with > 8 ozf are considered too powerful for effective use in commercial foodservice dish washing applications. As such, measure offerings include units with spray force < 5.0 ozf and those with spray force > than 5.0 ozf.

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[1] U.S Environmental Protection Agency (EPA). (n.d.) "WaterSense: Pre-rinse Spray Valves."

[2] American Society for Testing and Materials (ASTM). 2013. *ASTM F2324-13, Standard Test Method for Pre-rinse Spray Valves.* West Conshohocken (PA): ASTM International.

BASE CASE DESCRIPTION

The base case of the low-flow pre-rinse spray valve (PRSV) is defined by federal minimum standards set forth by the U.S. Department of Energy (see Code Requirements). The maximum flow rate requirements depend on the spray force rating (ounce-force, ozf). The 2019 Department of Energy (DOE) Federal Minimum Standard[3] specifies a maximum flow rate of 1.00 gpm for spray valves delivering < 5.0 ozf, 1.20 gpm for 5.0 ozf to 8.0 ozf, and 1.28 gpm for > 8.0 ozf.

Spray valves with < 4 ozf are considered to be ineffective for most commercial food service applications and those with > 8 ozf are considered too powerful for effective use in commercial foodservice dish washing applications.

CODE REQUIREMENTS

This measure is governed the Code of Federal Regulations (10 CFR 431.263). This measure is not covered by the California Building Energy Efficiency Standards (Title 24). The California Appliance Efficiency Regulations will align with the 2019 federal standards.

Applicable State and Federal Codes and Standards

Code	Applicable Code Reference	Effective Date
CA Appliance Efficiency Regulations – Title 20 (2019)	Aligns with Federal Standard)	January 28, 2019
CA Building Energy Efficiency Standards – Title 24	None.	n/a
Federal Standards	10 CFR 431.263	January 28, 2019

The federal minimum standard (10 CFR 431.263), effective on January 28, 2019, requires conformance with the ASTM Standard Test Method for the Performance of Pre-Rinse Spray Valves (F2324-13)[4] for estimating the energy and water consumption and cleaning performance of the spray valve. DOE determined that spray force is a performance-related feature that justifies different standard levels. Consequently, the DOE Final Ruling established three product classes based on spray force, specified in the table below.

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

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

[3] U.S. Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy. 2016. *Energy Conservation Program: Energy Conservation Standards for Commercial Prerinse Spray Valves.* Federal Register Vol. 81, No. 17. January 27.

[4] American Society for Testing and Materials (ASTM). 2013. *ASTM F2324-13, Standard Test Method for Pre-rinse Spray Valves.* West Conshohocken (PA): ASTM International.

NORMALIZING UNIT

Each

PROGRAM REQUIREMENTS

Measure Implementation Eligibility

All combinations of measure application type, delivery type, and sector that are established for this measure are specified below. Measure application type is a categorization based on the circumstances and timing of the measure installation; each measure application type is distinguished by its baseline determination, cost basis, eligibility, and documentation requirements. Delivery type is the broad categorization of the delivery channel through which the market intervention strategy (financial incentives or other services) is targeted. This table also designates the broad market sector(s) that are applicable for this measure.

Note that some of the implementation combinations below may not be allowed for some measure offerings by all program administrators.

Implementation Eligibility

Measure Application Type	Delivery Type	Sector
Normal replacement	DnDeemed	Ag
Normal replacement	DnDeemed	Ind
Normal replacement	DnDeemed	Com
Normal replacement	DnDeemDI	Ag
Normal replacement	DnDeemDI	Ind
Normal replacement	DnDeemDI	Com
New construction	DnDeemed	Ag
New construction	DnDeemed	Ind
New construction	DnDeemed	Com
New construction	DnDeemDI	Ag
New construction	DnDeemDI	Ind
New construction	DnDeemDI	Com

Eligible Products

This measure is defined as a new commercial-grade PRSV with a maximum flow rate ≤ 1.07 gpm that replaces a PRSV with a maximum flow rate of 1.20 gpm for a spray force of > 5.0 ozf and ≤ 8.0 ozf; and as a new commercial-grade PRSV with a maximum flow rate ≤ 0.75 gpm that replaces a PRSV with a maximum flow rate of 1.00 gpm for a spray force of < 5.0 ozf. See Measure Case Description.

This measure is restricted to operations with natural gas water heaters only.

Eligible Building Types and Vintages

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

Eligible Climate Zones

This measure is applicable in any California climate zone.

PROGRAM EXCLUSIONS

Used or rebuilt equipment is not eligible.

DATA COLLECTION REQUIREMENTS

Data collection requirements are to be determined.

USE CATEGORY

Food service (FoodServ)

ELECTRIC SAVINGS (kWh)

Not applicable.

PEAK ELECTRIC DEMAND REDUCTION (kW)

Not applicable.

GAS SAVINGS (Therms)

The annual gas energy savings per unit are based on the decrease in the flow rate (in gpm) between the base case pre-rinse spray valve (PRSV) and the measure case flow rate utilized during the pre-rinse process.

Summaries of PRSV Studies

Low-flow PRSVs have been included in energy efficiency programs in California, Washington, and Canada for several years. These programs have been evaluated to validate the effectiveness of low-flow PRSVs and to document operational characteristics. Two separate studies conducted by Tso and Koeller[5] and

[5] Tso, B and J. Koeller. 2005. *Pre- Rinse Spray Valves Programs: How are they Really Doing?* Bellevue (WA): SBW Consulting.

SBW Consulting[6] document the base case operating hours, base case flow rates, measure case operating hours, measure case flow rates, mixed water temperature, and supply water temperature for PRSVs. The results of these studies serve as the basis for the energy savings calculations for this measure. A summary of each study is provided below.

Pre-Rinse Spray Valve Programs: How Are They Really Doing? (Tso and Koeller 2005). The 2005 study by Tso and Koeller[7] randomly selected 16 different commercial food service sites out of 17,000 PRSV installation sites for monitoring and verification. All sites were located where a high-flow PRSV was initially measured for flow rate, hours of operation, and mixed water temperature, and subsequently monitored with a low-flow nozzle. The study was conducted in food service facilities throughout California, Washington, and Canada during 2003 to 2005. The research was conducted through a combination of equipment monitoring and surveys to evaluate the baseline operating hours, baseline flow rates, proposed operating hours, proposed flow rates, mixed water temperature, and supply water temperature for each facility in the sample.

- The mixed water temperatures for food service establishments averaged 114.1 °F during the monitoring period.
- The baseline operating hours were derived from the results of existing evaluation studies for restaurant facilities that included baseline operating hours of 0.79 hours per day for a 2.92 gpm unit and the proposed operating hours of 1.02 hours per day for a 1.18 gpm unit. The linear relationship between these two parameters yielded an equation that was used to calculate operating hours for the baseline unit at 1.40 gpm. Using the equation below, the difference in the hours of operation between the base and measure case is 0.033 hours per day (3%) and is assumed to be negligible for this work paper.

$$Hours/day = -0.1322 \times Flow\ Rate + 1.176$$

The measure flow rate is the rated flow of 1.15 gpm for the qualifying low-flow PRSVs. Using the equation above, the calculated measure hours of operation shown in the "Low-Flow PRSV Energy Use Parameters" table below are consistent with the results of the CUWCC PRSV program evaluation studies. Using the equation above, the difference in the hours of operation between the base case and measure case is 0.033 hours per day (3%) and is assumed to be negligible.

Impact and Process Evaluation Final Report for the CUWCC Pre-Rinse Spray Valve Program (SBW Consulting, 2007). This study conducted by SBW Consulting[8] documents the findings and results of the second phase of the CUWCC Spray Valve Program. The research included a combination of equipment monitoring and surveys 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 in the sample. The study documented 195 different spray valve installations, 29 of which were monitored for flow rate and temperature for at least one month.

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[6] SBW Consulting. 2007. *Impact and Process Evaluation Final Report for California Urban Water Conservation Council 2004-05 Pre-Rinse Spray Valve Installation Program (Phase 2).* Prepared for the California Public Utilities Commission. CALMAC Study ID CUW0001.01.

[7] Tso, B and J. Koeller. 2005. *Pre- Rinse Spray Valves Programs: How are they Really Doing?* Bellevue (WA): SBW Consulting.

[8] SBW Consulting. 2007. *Impact and Process Evaluation Final Report for California Urban Water Conservation Council 2004-05 Pre-Rinse Spray Valve Installation Program (Phase 2).* Prepared for the California Public Utilities Commission. CALMAC Study ID CUW0001.01.

The energy savings calculation assumptions were as follows:

- Supply water temperature was assumed to have an average annual temperature of 63.2 °F (in the PG&E service territory).
- Mixed water temperatures were not used from this report because it favored grocery type establishments that had a lower mixed water temperature unrepresentative of all food service building types.

Pre-Rinse Operations Field Evaluation Report. (Delagah and Karas, 2018). This study conducted for the Metropolitan Water District[9] provided data on pre-rinse operations in commercial kitchens. The study focused on larger operations in corporate and university cafeterias with conveyor dishwashing machines. Out of a total of 16 sites, PRSVs were sub metered at six sites; the results revealed an average of 1.55 operating hours per day. Assuming larger facilities operate PRSVs longer, this hourly usage aligns with the 1.0 hour per day assumed for this measure analysis, which includes smaller facilities.

Calculation of Unit Energy Consumption

The annual energy consumption (UEC) of a PRSV is represented by the following equation:[10]

$$UEC\_YEAR = FlowRate \times 60 \times \rho \times cp \times (T_{mixed} - T_{supply}) \times HOURS \times DAYS \div TE \div 100{,}000$$

$UEC\_YEAR =$	*Annual energy consumption*
$FlowRate =$	*Flow rate (gallons/minute)*
$\rho =$	*Density of water is 8.33 (lbm/gal)*
cp	*Specific heat of water is 1.0 (btu/lbm-°F)*
T_{mixed}	*Temperature of mixed water (°F)*
T_{supply}	*Temperature of supply water (°F)*
$HOURS =$	*Daily operating hours (hours/day)*
$DAYS =$	*Annual days of operation (days/year)*
$TE =$	*Thermal efficiency of natural gas water heating unit*

Calculation of Unit Energy Savings

The annual unit energy savings (UES) of a measure case PRSV is calculated as the difference between the of the base case and measure case UEC.

$$UES\_YEAR = UEC\_YEAR_{base} - UEC\_YEAR_{measure}$$

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[9] Delagah, A., and A. Karas (Frontier Energy). 2018. *Pre-Rinse Operations Field Evaluation Report. Report #50136-R0*. Conducted for the Innovative Conservation Program of the Metropolitan Water District of Southern California.

[10] American Society for Testing and Materials (ASTM). 2013. *ASTM F2324-13, Standard Test Method for Pre-rinse Spray Valves.* West Conshohocken (PA): ASTM International.

Inputs and Assumptions

The following table provides the calculation inputs to derive the annual UEC for the base case and measure case PRSVs.

UEC Inputs

Parameter	Base Case Model	Measure Case Model	Source
Temperature of Mixed Water (°F)	114.1	114.1	Tso, B and J. Koeller. 2005. *Pre- Rinse Spray Valves Programs: How are they Really Doing?* Bellevue (WA): SBW Consulting.
Temperature of Supply Water (Groundwater) (°F)	63.2	63.2	SBW Consulting. 2007. *Impact and Process Evaluation Final Report for California Urban Water Conservation Council 2004-05 Pre-Rinse Spray Valve Installation Program (Phase 2).* Prepared for the California Public Utilities Commission. CALMAC Study ID CUW0001.01.
Thermal Efficiency of Natural Gas Water Heater	0.76	0.76	California Public Utilities Commission (CPUC), Energy Division. 2014. "DEER-WaterHeater-Calculator-v1.1.xlsm." Updated November 29, 2014. See DEER DHW Properties tab. Itron, Inc. and ERS, Inc. 2016. *2014 Nonresidential Downstream Deemed ESPI Pipe Insulation Impact Evaluation Report.* Prepared for the California Public Utilities Commission.
Operating Hours/Day (hours)	1.0	1.0	SBW Consulting. 2007. *Impact and Process Evaluation Final Report for California Urban Water Conservation Council 2004-05 Pre-Rinse Spray Valve Installation Program (Phase 2).* Prepared for the California Public Utilities Commission. CALMAC Study ID CUW0001.01. Tso, B and J. Koeller. 2005. *Pre- Rinse Spray Valves Programs: How are they Really Doing?* Bellevue (WA): SBW Consulting.
Operating Days per Year (days)	365	365	

LIFE CYCLE

Effective useful life (EUL) is an estimate of the median number of years that a measure installed through a program is still in place and operable. Remaining useful life (RUL) is an estimate of the median number of years that a technology or piece of equipment replaced or altered by an energy efficiency program would have remained in service and operational had the program intervention not caused the replacement or alteration.

The EUL and RUL presented for low-flow PRSVs are presented below. Note that RUL is only applicable for add-on equipment and accelerated replacement measures thus not applicable for PRSVs.

Effective Useful Life and Remaining Useful Life

Parameter	Value	Source
EUL (yrs)	5.0	SBW Consulting. 2007. *Impact and Process Evaluation Final Report for California Urban Water Conservation Council 2004-05 Pre-Rinse Spray Valve Installation Program (Phase 2).* Prepared for the California Public Utilities Commission. CALMAC Study ID CUW0001.01.
RUL (yrs)	n/a	n/a

BASE CASE MATERIAL COST ($/UNIT)

The estimated base case material cost was calculated as the average of PRSV cost data from major online retailers obtained in September 2018, primarily from WebstaurantStore (www.webstaurantstore.com), the largest online food service equipment retailer. Base cost was determined for federally regulated spray valves between 1.07 gpm and 1.20 gpm because higher-flow PRSVs are standard practice. All valves selected for analysis meet the U.S. Department of Energy 1.20 gpm threshold.

Base Case Material Cost Data

Product Category	Spray Force (ozf)	Maximum Rated Flow Rate (gpm)	Make	Model	Cost ($)
> 5.0 ozf > 0.75 gpm	7.5	1.15	Fisher	2949	$41.99
	7.5	1.15	Fisher	2949R	$41.99
	7.5	1.15	Fisher	71307	$61.99
	7.7	1.20	T&S Brass	5SV-C	$38.49
				Average	**$46.12**

MEASURE CASE MATERIAL COST ($/UNIT)

The estimated measure case material cost was derived from PRSV cost data from major online retailers obtained in September 2018, primarily from WebstaurantStore (www.webstaurantstore.com), the largest online foodservice equipment retailer. All valves selected for analysis meet the U.S. Department of Energy 1.20 gpm threshold.

Measure Case Material Cost Data

Product Category	Spray Force (ozf)	Maximum Rated Flow Rate (gpm)	Make	Model	Cost ($)
4.0 ozf – 5.0 ozf < 0.75 gpm	4.2	0.7	Fisher	10197	$72.99
	4.2	0.7	Fisher	13641	$43.99
	4.4	0.65	T&S Brass	B-0107-C	$49.99
	4.4	0.65	T&S Brass	EB-0107-C	$58.99
	4.6	0.65	T&S Brass	B-0108-C	$69.99
	4.9	0.74	Encore Series	KLP50-0220-74	$113.85
				Average	**$68.30**
> 5.0 ozf > 0.75 gpm	6.4	1.0	Chicago Faucet	90-ANGABCP	$76.38
	6.4	1.0	Chicago Faucet	90-LABCP	$49.93
	6.8	1.05	Encore Series	KLP50-Y002105	$97.81
	6.8	1.05	Encore Series	KLP50-0220105	$113.85

Product Category	Spray Force (ozf)	Maximum Rated Flow Rate (gpm)	Make	Model	Cost ($)
	7.2	1.07	T&S Brass	B-0107-J	$47.52
	7.2	1.07	T&S Brass	EB-0107-J	$58.99
				Average	**$70.97**

BASE CASE LABOR COST ($/UNIT)

A low-flow PRSV does not require additional labor compared to the standard base case equipment. Since this measure is applicable for normal replacement and new construction installations, the installation and maintenance costs are expected to be the same for the customer and thus not estimated for the cost analysis.

MEASURE CASE LABOR COST ($/UNIT)

A low-flow PRSV does not require additional labor or maintenance compared to the standard base case equipment. Since this measure is applicable for normal replacement and new construction installations, the installation and maintenance costs are expected to be the same for the customer and thus not estimated for the cost analysis.

NET-TO-GROSS (NTG)

The net-to-gross (NTG) ratio represents the portion of gross impacts that are determined to be directly attributed to a specific program intervention. These NTG values are based upon the average of all NTG ratios for all evaluated 2006 – 2008 commercial, industrial, and agriculture programs, as documented in the 2011 DEER Update Study conducted by Itron, Inc. These sector average NTGs ("default NTGs") are applicable to all energy efficiency measures that have been offered through commercial, industrial, and agriculture sector programs for more than two years and for which impact evaluation results are not available.

Net-to-Gross Ratios

Parameter	Value	Source
NTG – Commercial	0.60	Itron, Inc. 2011. *DEER Database 2011 Update Documentation.* Prepared for the California Public Utilities Commission. Page 15-4 Table 15-3.
NTG – Industrial	0.60	
NTG - Agriculture	0.60	

GROSS SAVINGS INSTALLATION ADJUSTMENT (GSIA)

The gross savings installation adjustment (GSIA) rate represents the ratio of the number of verified installations of the measure to the number of claimed installations reported by the utility. This factor varies by end use, sector, technology, application, and delivery method. This GSIA rate is the current "default" rate specified for measures for which an alternative GSIA has not been estimated and approved.

Gross Savings Installation Adjustment

Parameter	Value	Source
GSIA	1.0	California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 31.

NON-ENERGY IMPACTS

The reduction in water usage is the primary non-energy impact associated with the installation of a low-flow PRSV. Annual water use (base case or measure case) is calculated as the sum of the hot, cold, and mixed temperature water usage.

$$Water\ Use = FlowRate_{total} \times HOURS \times \mathrm{DAYS} \times \mathrm{MIN}$$

$WaterUse =$ *Annual water use, base or measure (gal/yr)*
$FlowRate_{total} =$ *Total flow rate of hot, cold, and mixed temperature water (gal/min)*
$HOURS =$ *Daily operating hours (hours/day)*
$DAYS =$ *Annual days of operating (days/year)*
$MIN =$ *Constant minutes per hour*

The water saved by installing a qualified low-flow PRSV is calculated as the difference between the base case and measure case water usage.

$$Water\ Savings = Water\ Use_{Base} - Water\ Use_{Measure}$$

The base case and measure case parameters to estimate the water use and savings associated with low-flow PRSVs are provided below.

Low-Flow PRSV Annual Water Savings Inputs

Parameter	Base Case Model	Measure Case Model	Source
Operating Hours per Day (hours)	1.0	1.0	SBW Consulting. 2007. *Impact and Process Evaluation Final Report for California Urban Water Conservation Council 2004-05 Pre-Rinse Spray Valve Installation Program (Phase 2).* Prepared for the California Public Utilities Commission. CALMAC Study ID CUW0001.01. Tso, B and J. Koeller. 2005. *Pre- Rinse Spray Valves Programs: How are they Really Doing?* Bellevue (WA): SBW Consulting.
Operating Days per Year (days)	365	365	

DEER DIFFERENCES ANALYSIS

This section provides a summary of inputs and methods based upon the Database for Energy Efficient Resources (DEER), and the rationale for inputs and methods that are not DEER-based. The DEER database does not contain information on energy use, savings, equipment and labor costs, hours of operation for the low-flow PRSV measure.

DEER Difference Summary

DEER Item	Comment / 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	DEER 2018, READI v 2.4.8
Reason for Deviation from DEER	DEER does not contain this measure.
DEER Measure IDs Used	n/a
NTG	Source: DEER 2014. The value of 0.60 is associated with NTG Ids: *Com-Default>2yrs*, *Ag-Default>2yrs*, *Ind-Default>2yrs*
GSIA	Source: DEER. The value of 1.0 is associated with GSIA ID: *Def-GSIA*
EUL/RUL	Source DEER. The value of 5 years is associated with EUL ID: *Cook-LowPreRinse* was derived from Tso and Koeller (2005).

REVISION HISTORY

Measure Characterization Revision History

Revision Number	Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision Effective Date and Approved By
01	08/31/2017	Jennifer Holmes Cal TF Staff	Draft of consolidated text for this statewide measure is based upon: PGECOFST125, Revision 1 (April 1, 2016) WPSCGNRWH121113A WPSDGENRWH0012, Revision 1 (October 4, 2016) Consensus reached among Cal TF members.
	1/11/2019	Andres Marquez SCG	Update text based upon: WPSCGNRWH121113A, Revision 4 (December 18, 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 gpm – 1.07 gpm. Updated delivery types as per DEER2019.
	1/31/2019	Jennifer Holmes Cal TF Staff	Final revisions for submittal of version 01.