
# Pre-Rinse Spray Valves Field Study Report

**February 1, 2011**

# Summary

Pre-rinse spray valves (PRSVs) are used in commercial food operations for the purpose of removing food waste from dishes prior to dishwashing. PRSVs can consume nearly one-third of the water used in the dish room. Of the PRSVs currently in use in commercial kitchens across the United States, many have flow rates exceeding the current 1.6 gallon per minute (gpm) maximum flow rate allowed by the Energy Policy Act of 2005 (EPAct). Over the past several years, manufacturers have developed high-efficiency PRSVs with flow rates lower than the standard.

To capitalize on the opportunity for potential water and energy savings, on July 10, 2009, the U.S. Environmental Protection Agency (EPA) announced its intent to develop a specification for water-efficient, energy-efficient, and high-performing PRSVs for the WaterSense® and ENERGY STAR® programs.

The WaterSense program labels products that not only save water, but also perform as well as or better than standard models. Though EPAct 2005 specifies the maximum flow rate for PRSVs, it does not address the performance of these products. To provide a mechanism to compare PRSV efficiency and performance, the *ASTM F2324-03 Standard Test Method for Pre-Rinse Spray Valves* (hereafter referred to as *ASTM F2324*) was developed. In accordance with the test method, product efficiency is determined by measuring flow rate in gpm. Product performance is determined by measuring ~~c~~leanability," or the time it takes for the PRSV to rinse tomato paste from a plate, in units of seconds per plate.

Though *ASTM F2324* provides a measure for PRSV performance, during EPA's initial evaluation of this product category, it received input from some of its utility partners and other stakeholders with concerns about the following:

- PRSVs with flow rates less than 1.0 gpm are used longer in the field than higher flowing PRSVs. As a result, high-efficiency PRSVs might save less water than expected.
- Users are generally not satisfied with high-efficiency PRSV performance, although these same PRSVs score well on the *ASTM F2324* cleanability test.

Because it is interested in labeling water- and energy-efficient PRSVs that perform as well or better than standard PRSVs, EPA decided that it needed additional field data on PRSVs before developing a specification that addresses water use, energy use, and performance. From January through June 2010, EPA monitored PRSV use at 10 commercial and institutional kitchens. The objectives of the study were to determine if:

- High-efficiency PRSVs save less water than expected because users have to spend more time rinsing dishes;
- Users are less satisfied with high-efficiency PRSVs; and
- The *ASTM F2324* cleanability test method provides an indication of PRSV performance in the field.

EPA's contractor, Eastern Research Group, Inc. (ERG), collected water use, use time, operating flow rate, and user satisfaction data at 10 commercial kitchen facilities in the Washington, D.C.

and Boston, Massachusetts, areas. The 10 participating facilities included four university dining halls, one high school cafeteria, and five restaurants.

ERG monitored the existing PRSV at each facility for three weeks. Then, ERG installed and monitored three new PRSVs for three weeks each at each facility. The PRSVs included in the study had flow rates ranging from 0.5 to 1.6 gpm and varying cleanability times ranging from 17 to 26 seconds per plate when evaluated in accordance with the *ASTM F2324* test method. At the end of each three-week monitoring period, ERG surveyed the PRSV users to assess their satisfaction with each PRSV.

Using the data collected, EPA evaluated the following in order to provide analyses to support the research objectives:

- The relationship between water use and PRSV operating flow rates;
- The relationship between use time and PRSV operating flow rates;
- The relationship between use time and cleanability time;
- User satisfaction as compared to PRSV operating flow rates, use time, and cleanability time; and
- Additional quantitative and qualitative user feedback.

From these analyses, EPA concluded that use time remained relatively constant among the PRSVs tested and that high-efficiency PRSVs did use less water and energy. EPA also found that users were less satisfied with PRSVs that flowed at less than 1.0 gpm. However, EPA concluded that use time did not have a perceivable impact on user satisfaction in this study, which may be because use time remained relatively constant among the PRSVs tested and users could not perceive a difference in the amount of time they used each PRSV. EPA also found that the *ASTM F2324* cleanability test did not indicate which of the PRSVs tested the users preferred, nor was it an indicator of actual use time in the field. Since several users indicated pressure (i.e., spray force) as a reason for dissatisfaction, pressure may be a factor that EPA should consider for differentiating PRSV performance.

Because PRSVs have demonstrated significant water and energy savings potential, EPA will continue working with stakeholder groups to identify and develop requirements that high-efficiency PRSVs must meet in order to provide the expected performance. In addition, EPA will evaluate other issues that became apparent throughout the study, such as addressing PRSV life cycle testing and determining why some PRSVs may have operating flow rates far different than their flow rates tested using the *ASTM F2324* test method. EPA's ultimate goal is to create a specification that ensures long-term water and energy savings and acceptable performance.

## CONTENTS

**Page**

## LIST OF TABLES

**Page**



## LIST OF FIGURES

**Page**

# Pre-Rinse Spray Valves Field Study Report

## 1 Background

Commercial pre-rinse spray valves (PRSVs) are nozzles that spray hot water under pressure to remove food and grease from dishes, pots, pans, and utensils before they are put into a dishwasher. In typical commercial food operations, dishwashing consumes nearly two-thirds of all the water used. Of that water, nearly half is consumed by PRSVs for the purpose of removing food waste from dishes prior to dishwashing.[1]

An estimated 1.35 million[2] commercial PRSVs are in use in the United States. Many of these PRSVs may be inefficient units, with flow rates exceeding the current 1.6 gallons per minute (gpm) maximum flow rate allowed by the federal standard governing such devices, the Energy Policy Act of 2005 (EPAct 2005). These non-EPAct 2005-compliant PRSVs flow between 3.0 and 5.0 gpm. Since Congress enacted the federal standard, however, manufacturers have developed high-efficiency PRSVs with flows as low as 0.5 gpm.

To capitalize on this opportunity for potential water and energy savings, on July 10, 2009, the U.S. Environmental Protection Agency (EPA) announced its intent to develop a specification for water-efficient, energy-efficient, and high-performing PRSVs for the WaterSense® and ENERGY STAR® programs.

The WaterSense program labels products that use less water and perform as well as or better than standard models. Although EPAct 2005 specifies the maximum flow rate for PRSVs, it does not address the performance of PRSVs. To provide a mechanism to compare PRSV efficiency and performance, Pacific Gas and Electric's Food Service Technology Center (FSTC) developed a timed test to measure the ability of a PRSV to clean a plate. The FSTC test method was later used by the California Urban Water Conservation Council (CUWCC) to select PRSVs for their PRSV replacement program and was eventually adopted by the American Society for Testing and Materials (ASTM International) as *ASTM F2324-03 Standard Test Method for Pre-Rinse Spray Valves* (hereafter referred to as *ASTM F2324*).

In accordance with the *ASTM F2324* test method, a PRSV's efficiency is determined by measuring its flow rate in gpm. A PRSV's performance is determined by measuring its ~~c~~leanability," or the average amount of time the PRSV takes to clean tomato paste from a set of plates, in units of seconds per plate.

The *ASTM F2324* test method was originally developed to help water and energy utilities select high-efficiency PRSVs for their efficiency incentive programs by differentiating products that used flow restrictors to achieve a lower flow rate, without regard to performance. However,

[1] California Urban Water Conservation Council. February 2005. *Rinse & Save Program Final Report Summary.*

[2] The National Restaurant Association (NRA) estimates that 945,000 commercial food establishments are present in the United States as of January 2008. A Puget Sound Energy (PSE) direct-install program estimated that approximately 70 percent of facilities using PRSVs are restaurants (Tso, Bing, P.E. and John Koeller, P.E. *Pre-Rinse Spray Valve Programs: How are They Really Doing?* December 1, 2005. p. 1-12.). Assuming one PRSV per restaurant, if restaurants are 70 percent of the market, then the total number of PRSVs nationwide can be estimated to be 1.35 million.

several organizations now use the test method to further differentiate PRSV performance among those products that do not use flow restrictors by specifying a maximum flow rate and cleanability threshold that products must meet, as shown in Table 1.

**Table 1. Regulations and Voluntary Requirements for Pre-Rinse Spray Valves**

| Group | Regulation | Domain | Maximum Flow Rate | Maximum Cleanability Threshold | Effective Date |
|---|---|---|---|---|---|
| California Energy Commission (CEC) | *Appliance Efficiency Regulations* | Required for all PRSVs sold in the state of California | 1.6 gpm | 30 seconds per plate | January 1, 2006 |
| Federal Energy Management Program (FEMP) | Purchasing specifications for federal agencies | Required for all PRSVs purchased by federal agencies | 1.25 gpm | 26 seconds per plate | December 2008 |
| American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. (ASHRAE) | *Standard 189.1-2009, Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings* | Voluntary standard—only required for those buildings meeting the standard | 1.3 gpm | 26 seconds per plate | December 2009 |
| California Urban Water Conservation Council (CUWCC) | *Rinse & Save Program* (direct installation program) | Voluntary program—only required for those PRSVs selected for the direct installation program | 1.6 gpm | 21 seconds per plate | 2002-2007 |
| Arizona Department of Water Resources | Arizona Rinse Smart (direct installation program) | Voluntary program—only required for those PRSVs selected for the direct installation program | 1.6 gpm | 21 seconds per plate | Began 2005 |
| New York State Energy Research and Development Authority | Focus on Hospitality (rebate program) | Voluntary program—only required for those PRSVs selected for the rebate program | 1.6 gpm | 26 seconds per plate | Began 2004 |

Although these groups have established flow rate and cleanability maximums for PRSVs, EPA received input from some of its utility partners and other stakeholders that the following might be occurring:

- PRSVs with flow rates less than 1.0 gpm are used longer in the field than higher flowing PRSVs. As a result, high-efficiency PRSVs might save less water than expected.
- Users are generally not satisfied with high-efficiency PRSV performance, although these same PRSVs score well on the *ASTM F2324* cleanability performance test.

These concerns raised questions of whether EPA should use *ASTM F2324* to assess PRSV performance and as a result, EPA determined that it needed additional field data on PRSVs before developing a specification that addresses water use, energy use, and performance.

In September 2009, EPA hosted a stakeholder meeting to discuss these outstanding concerns and presented for comment a draft of its research study scope outlining the study objectives and EPA's general approach for collecting PRSV field data. In October 2009, EPA joined the American Society of Mechanical Engineers/Canadian Standards Association (ASME/CSA) Joint Harmonization Task Force on Water-Efficient PRSVs (task force), agreeing to collaborate with ASME/CSA and ASTM on the development of a PRSV performance specification. During the initial task force meetings, EPA discussed comments and revisions to its research study scope and agreed to conduct research at 10 commercial and/or institutional facilities. Realizing the limitations of a small data set, EPA attempted to recruit other parties interested in conducting similar research. To date, no other organizations have agreed to provide such data. EPA published its final research study scope on October 26, 2009, which guided its field research.

This report presents EPA's PRSV field research objectives, methodology, results, potential water and energy savings, conclusions, and next steps. Supporting information—including EPA's Pre-Rinse Spray Valves Research Study Scope, weekly site visit measurements form, user satisfaction survey, raw data, user satisfaction survey responses, and facility operations survey responses—are provided in appendices to this document.

## 2 Terminology

Key terminology used in this report is defined below.

- Non-EPAct 2005-compliant PRSVs: Commercial PRSVs that flow higher than the maximum EPAct 2005 standard of 1.6 gpm.

- EPAct 2005-compliant PRSVs: Commercial PRSVs that meet the maximum EPAct 2005 standard of 1.6 gpm. This term encompasses standard and high-efficiency PRSVs, defined below.

- Standard PRSVs: Commercial PRSVs that have tested flow rates between 1.25 and 1.6 gpm.

- High-efficiency PRSVs: Commercial PRSVs that are at least 20 percent more efficient than the current federal standard; specifically in this report, the term refers to PRSVs that have tested flow rates of 1.25 gpm or less.

- Tested flow rate: The flow rate (in gpm) provided on the Food Service Technology Center's (FSTC's) website for each PRSV it tests using the *ASTM F2324* test method. The flow rate is collected per the test method at a flowing water pressure of 60 pounds

per square inch (psi). The tested flow rate for each PRSV is not provided in this report in order to mask the model names of PRSVs evaluated.

- Operating flow rate: The flow rate (in gpm) measured in the field during this study, calculated as the average of the weekly operating flow rate measurements for a PRSV at each test facility. The operating flow rate is measured at the flowing pressure in each facility and is described further in Section 4.3.1.

- Recorded flow rate: The average flow rate (in gpm) recorded by the data logger over a 10-second interval. The flow rate is recorded by the data logger at the flowing pressure in each facility.

- Cleanability time: Cleanability time (in seconds per plate) reported on FSTC's website for each PRSV it tested using the *ASTM F2324* test method. The cleanability times provided in this report were rounded to the nearest whole number, in order to mask the model names of PRSVs evaluated.

## 3 Objectives

To examine the water use, energy use, use time, and user satisfaction of high-efficiency PRSVs, EPA initiated a 12-week field study at 10 commercial kitchen facilities in the Washington, DC, and Boston, Massachusetts, areas. The intent of this research was to answer the questions outlined in EPA's Pre-Rinse Spray Valves Research Study Scope, dated October 26, 2009 (see Appendix A). The objectives of the study were to determine if:

- High-efficiency PRSVs save water;
- Users require more time to rinse dishes when using high-efficiency PRSVs;
- The *ASTM F2324* cleanability test method accurately predicts whether a user will spend more time using a given PRSV in the field;
- Users are less satisfied with high-efficiency PRSVs;
- Users are less satisfied with PRSVs that they have to use for more time in order to rinse the dishes; and
- Users are more satisfied with PRSVs that have lower *ASTM F2324* cleanability times.

## 4 Methodology

This section describes facility selection, PRSVs monitored, and EPA's data collection methodology. Field research was conducted by Eastern Research Group, Inc. (ERG), an EPA contractor. ERG also worked under contract with EPA to analyze the data.

### 4.1 Facility Selection

ERG evaluated 22 facilities before choosing 10 at which to conduct field research. Facility eligibility was based on the requirements outlined in the Pre-Rinse Spray Valves Research Study Scope. ERG targeted facilities that:

- Had an existing PRSV with a tested flow rate less than or equal to 1.6 gpm;
- Used PRSVs prior to commercial dishwashing equipment; and
- Served on china dishware, not plasticware.

In addition, ERG evaluated other facility characteristics, including:

- Water temperature;[3]
- Typical facility customer throughput;
- Feasibility of water meter installation;
- Willingness to participate; and
- Estimated frequency of PRSV use.[4]

Following ERG's evaluation of the 22 potential facilities, EPA attempted to select facilities with existing PRSVs that met EPAct 2005 requirements, but 15 of the 22 facilities evaluated did not have EPAct 2005-compliant PRSVs in place. Adherence to this requirement was determined not to be feasible, and five of the final 10 facilities selected for the study did not have existing EPAct 2005-compliant PRSVs.

EPA targeted university dining halls with commercial kitchens for participation in the field study. University dining halls have a relatively consistent customer throughput that allows usage patterns to be easily distinguished. A private high school was chosen for the study for similar reasons. Because restaurants are an important user group and represent a majority of PRSV installations in the United States, EPA also selected five restaurants to participate in the study.

ERG developed study timelines based on facility operating schedules, taking into account facility closing periods such as university and school breaks. PRSVs were monitored at all facilities for three weeks (21 days), with the exception of the PRSVs monitored at Buckingham Browne & Nichols School (BB&N) (which were monitored for 12 days, because not enough operating days remained in the school year to collect a full 21-day data set for each PRSV monitored). The data collection period was set at three weeks to normalize for any anomalies or abnormalities that could occur at a facility. The field data collection period for each participating facility occurred between January and June 2010.

Table 2 lists the 10 selected facilities and includes general baseline information for each.

[3] Facilities with operating water temperatures well above the water meter operating temperature of 120°F were not selected.
[4] Facilities that did not use a PRSV as the main means of removing food waste from dishes prior to washing or used PRSVs primarily for purposes other than rinsing food waste from dishes were not selected.

**Table 2. Facilities Selected for EPA's Pre-Rinse Spray Valves Study**

| Facility Name | Existing EPAct 2005-compliant PRSV? | Operating Flow Rate of Existing PRSV (gpm) | Operating Water Temperature (°F) | Operating Static / Flowing Water Pressure (psi) | Approximate Weekly Customer Throughput |
|---|---|---|---|---|---|
| **University Dining Halls** | | | | | |
| Boston College McElroy Commons (BC McElroy), Chestnut Hill, MA [a] | No | 3.66 | 118 | 69 / 39 | 35,000 |
| Boston College Stuart Hall (BC Stuart), Newton, MA | No | 4.05 | 93 | 75 / 39 | 15,000 |
| Harvard University Mather House (Harvard Mather), Cambridge, MA [a] | Yes | 0.97 | 104 | 50 / 41 | 4,500 |
| Harvard University Currier House (Harvard Currier), Cambridge, MA | Yes | 1.08 | 99 | 52 / 48 | 4,800 |
| **Day School** | | | | | |
| BB&N, Cambridge, MA | No | 3.21 | 129 | 72 / 25 | 2,900 |
| **Restaurants** | | | | | |
| Founding Farmers, Washington, DC | Yes | 1.10 | 119 | 58 / 42 | 5,400 |
| Farmers & Fishers, Washington, DC | Yes | 1.17 | 126 | 62 / 55 | 3,000 |
| Mario's Italian Restaurant, Lexington (Mario's), MA | No | 4.31 | 85 | 91 / 48 | 1,500 |
| Jimmy's Steer House (Jimmy's), Arlington, MA | No | 2.62 | 75 | 67 / 39 | 5,400 |
| The Fireplace Restaurant (The Fireplace), Brookline, MA | Yes | 1.04 | 113 | 73 / 59 | 1,200 |

a – Harvard Mather and BC McElroy had two PRSVs each, all of which are used for rinsing dishes before they are put into a commercial dishwasher. At these two facilities, both existing PRSVs were replaced with the same model of new PRSV during each monitoring period to ensure that one PRSV was not favored over the other. However, only one PRSV at each facility was equipped with a data logger to capture detailed usage patterns.

## 4.2 Pre-Rinse Spray Valves

Because one of the objectives of the study was to determine whether the *ASTM F2324* test method indicates PRSV performance and use time in the field, EPA only included PRSVs in the study that had been previously tested by the FSTC in accordance with the *ASTM F2324* test method. Where feasible, participating facilities were given one PRSV to test from each of the following three flow rate categories (based upon their tested flow rate as reported by FSTC):

- Category 1: PRSVs with a tested flow rate of 1.25 to 1.6 gpm
- Category 2: PRSVs with a tested flow rate of 1.0 to 1.25 gpm
- Category 3: PRSVs with a tested flow rate less than 1.0 gpm

The PRSVs for each facility were selected at random and installed in a random order. Users were not told the tested flow rate of the PRSVs being installed. No training was provided to users when new PRSVs were installed.

Table 3 provides a list of PRSVs monitored in the study (masked to conceal model names), including the operating flow rate for each model in the field, the cleanability time each achieved on the *ASTM F2324* test, and a list of the facilities where each model was evaluated. To develop the most robust user satisfaction data set possible, ERG monitored each PRSV in at least two facilities, with the exception of a few PRSVs, as noted in the table.

**Table 3. Pre-Rinse Spray Valves Evaluated**

| PRSV | Operating Flow Rate (gpm) [a] | Rounded Cleanability Time (seconds per plate) | Facilities Where Evaluated |
|---|---|---|---|
| **Category 3 PRSVs (< 1.0 gpm)** | | | |
| N | 0.51 | 21 | • Harvard Mather |
| A | 0.61 | 21 | • Harvard Mather<br>• Jimmy's |
| J | 0.73 | 21 | • Harvard Currier<br>• BC McElroy<br>• Farmers & Fishers<br>• Mario's |
| H | 0.86 | 20 | • The Fireplace |
| E [b] | 1.58 | 25 | • Founding Farmers<br>• BB&N |
| M | 1.10 | 20 | • BC Stuart |

**Table 3. Pre-Rinse Spray Valves Evaluated**

| PRSV | Operating Flow Rate (gpm) [a] | Rounded Cleanability Time (seconds per plate) | Facilities Where Evaluated |
|---|---|---|---|
| **Category 2 PRSVs (≥ 1.0 to < 1.25 gpm)** | | | |
| L | 1.04 | 23 | • Harvard Currier<br>• Founding Farmers |
| I | 1.21 | 22 | • BC Stuart<br>• Jimmy's |
| C | 1.27 | 22 | • BC McElroy<br>• BB&N |
| G [b] | 1.58 | 23 | • Farmers & Fishers<br>• Mario's |
| B [b] | 1.52 | 24 | • BB&N<br>• The Fireplace |
| **Category 1 PRSVs (≥ 1.25 to 1.6 gpm)** | | | |
| K [b] | 1.09 | 17 | • Harvard Mather<br>• Harvard Currier<br>• BC Stuart<br>• Founding Farmers<br>• The Fireplace |
| D | 1.56 | 21 | • Harvard Currier<br>• BC McElroy<br>• Jimmy's<br>• The Fireplace |
| F | 1.44 | 21 | • Harvard Mather<br>• Founding Farmers<br>• Farmers & Fishers<br>• Mario's |

a – To conceal each PRSV's model name, the operating flow rates are provided in this table instead of tested flow rates. Since the operating flow rate in the field differed from the tested flow rate, some PRSVs may seem to be placed in the wrong category; however, PRSVs were originally categorized based on their tested flow rate.
b – Even taking into account the variability of flowing water pressure in the field, the operating flow rates for PRSVs E, G, and B were much higher than expected based on their tested flow rates. The operating flow rate for PRSV K was much lower than expected. As a result, these PRSVs were found to flow outside of their original designated flow rate category.

### 4.3 Data Collection Methodology

ERG installed and monitored the PRSVs discussed in Section 4.2 to assess the following key PRSV data parameters to help EPA evaluate its study objectives:

- Flow rate;
- Water use;
- Use time; and
- User satisfaction.

In addition, EPA assessed several other data parameters to obtain information about the PRSV operating conditions, including:

- Water temperature;
- Static water pressure;
- Flowing water pressure; and
- Facility operations (as collected via manager surveys).

The list of equipment ERG used during the weekly visits can be found in the Pre-Rinse Spray Valves Research Study Scope in Appendix A. The weekly site visit measurement forms used to record the data each week are presented in Appendix B. The user satisfaction survey form can be found in Appendix C. This section describes the how the data parameters were measured or calculated.

### *4.3.1 Flow Rate*

Using a bucket and stopwatch technique, ERG manually collected the PRSVs' flow rates each week using the settings established by the operator (operating flow rate). ERG also collected each PRSV's flow rate with the hot and cold faucet spigots fully open (maximum flow rate). ERG allowed the PRSV to flow for 10 seconds into a bucket and then measured the volume of water collected using a graduated cylinder. The measurements were converted to gpm. Each measurement was taken three times for accuracy, and the average of the readings was used in the data set.

### *4.3.2 Water Use and Use Time*

To acquire water use and use time information, ERG hired a plumber to install an Elster AMCO Water C700 water meter on the mixed hot and cold water line supplying the PRSV at each of the participating facilities. ERG then connected a Model 100EL or 100AF Meter-Master data logger to the water meter to record real-time water use data. A picture of a typical set-up is shown in Figure 1.

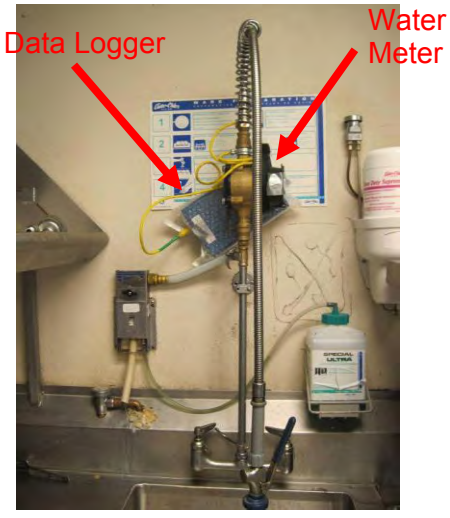


**Figure 1. Water Meter and Data Logger Set-Up**

The data logger recorded the average flow rate in gpm over 10-second intervals. ERG used a field laptop to download the data from the data logger at each facility during weekly site visits. In addition, ERG read the water meter at the beginning and end of each week. The water meter readings were input into the data logger software to calibrate the data logger output in accordance with the true measured volume of water.

ERG eliminated high and low outliers from the data set each week. Low outliers were removed when the recorded value was below the sensitivity threshold of the water meter. High outliers were removed when the recorded value was above the maximum flow rate of the PRSV, as measured in the field. After excluding the outliers, the water use calculated from the data logger output only differed from water use recorded by the water meter by 7 percent.

#### *4.3.2.1 Water Use*

To calculate the amount of water used by each PRSV for each time interval, ERG multiplied each of the data logger's average recorded flow rates by the 10-second time interval over which each data point was collected (converting the 10-second time interval to minutes to perform the calculation), as shown in the equation below.

| Water Use (gallons) = [average recorded flow rate output (gpm)] × 10 seconds × 1 minute / 60 seconds |
|---|

From this data, ERG summed the water use calculated for each individual 10-second interval to determine the total amount of water each PRSV used during each three-week monitoring period. See Table 4 for an example of the water use calculation.

#### *4.3.2.2 Use Time*

To calculate the time each PRSV was in use, ERG compared the data logger's average recorded flow rate over each 10-second interval to the PRSV's maximum recorded flow rate by the data logger. If the average recorded flow rate was equivalent to the maximum recorded flow rate, ERG assumed that the PRSV handle was fully depressed for the entire 10-second interval. If the average recorded flow rate was less than the maximum recorded flow rate, ERG assumed that the PRSV was only used for a portion of the 10-second interval. For each 10-second interval, it is possible to calculate the amount of time the PRSV was used by dividing the average recorded flow rate in gpm for that interval by the maximum recorded flow rate, and then multiplying this ratio by 10 seconds, as shown in the equation below. For example, if a 1.0 gpm PRSV had an average recorded flow rate value of 0.5 gpm during a 10-second interval, it would indicate that the PRSV was only operated for 50 percent of this 10-second period, or 5 seconds.

| Use Time (seconds) = [Average Recorded Flow Rate (gpm) / Maximum Recorded Flow Rate (gpm)] × 10 seconds |
|---|

From this data, ERG summed the use time calculated for each individual 10-second interval to determine the total amount of time each PRSV was used during each three-week monitoring period. See Table 4 for an example of the use time calculation. Note that 1.0 gpm was the maximum recorded flow rate in this example.

**Table 4. Example Data Logger Output and Use Time and Water Use Calculations Using 1.0 gpm Maximum Flow Rate**

| Date and Time | Average Recorded Flow Rate (gpm) during the 10 second Interval | Use Time (seconds) | Water Use (gallons) |
|---|---|---|---|
| 4/1/2010 1:00:10 PM | 0.00 | 0 | 0.00 |
| 4/1/2010 1:00:20 PM | 0.30 | = 0.30 / 1.00 × 10 = 3 | = 0.30 × 10 × 1/60 = 0.05 |
| 4/1/2010 1:00:30 PM | 0.40 | 4 | 0.07 |
| 4/1/2010 1:00:40 PM | 0.80 | 8 | 0.13 |
| 4/1/2010 1:00:50 PM | 0.90 | 9 | 0.15 |
| 4/1/2010 1:01:00 PM | 1.00 | 10 | 0.17 |
| 4/1/2010 1:01:10 PM | 1.00 | 10 | 0.17 |
| 4/1/2010 1:01:20 PM | 1.00 | 10 | 0.17 |
| 4/1/2010 1:01:30 PM | 1.00 | 10 | 0.17 |
| 4/1/2010 1:01:40 PM | 0.80 | 8 | 0.13 |
| 4/1/2010 1:01:50 PM | 0.60 | 6 | 0.10 |
| 4/1/2010 1:02:00 PM | 0.20 | 2 | 0.03 |
| 4/1/2010 1:02:10 PM | 0.00 | 0 | 0.00 |
| **TOTAL** | | **80** | **1.33** |

### *4.3.3 Water Temperature*

ERG collected the PRSV operating temperature and the hot water and cold water temperatures using a bucket and a digital thermometer. The operating temperature was collected by depressing the PRSVs without adjusting the faucet spigots, leaving the settings as the user had them prior to the site visit. The hot and cold water temperatures were collected by completely shutting off the opposite faucet spigot. ERG allowed the PRSV to flow so the temperature could stabilize prior to taking each measurement. Each measurement was taken three times for accuracy, and the average of the three readings was used in the data set. At the end of each site visit, the water temperature was returned to the original operating temperature.

### *4.3.4 Water Pressure*

Using a pressure adaptor and a pressure gauge, ERG collected static and flowing water pressure each week. The pressure adaptor and pressure gauge were installed in line after the PRSV unit's hose and before the PRSV itself. Static pressure was collected without depressing the PRSV handle, and flowing pressure was collected with the PRSV handle fully depressed. Both static and flowing water pressure were collected at the operating temperature and with the hot and cold water spigots completely open (to assess the maximum possible water pressure). Each measurement was taken three times for accuracy, and the average of the readings was used in the data set.

### *4.3.5 Surveys*

ERG surveyed the PRSV users to assess their satisfaction with each PRSV installed. ERG also surveyed the facility managers to collect important operating data to provide additional context during data analysis. This section describes the survey methodology.

#### *4.3.5.1 User Satisfaction*

ERG collected user satisfaction data for each PRSV by interviewing one or more user at each facility at the end of each three-week monitoring period, including the baseline monitoring period. ERG administered the survey either verbally or in written form (in languages other than English if necessary), depending on the preference of the user. The user satisfaction survey form can be found in Appendix C.

The user satisfaction survey included both quantitative and qualitative questions. Specifically, ERG asked the users to evaluate their impression of each PRSV by ranking their satisfaction as either 1 (unsatisfied), 2 (somewhat satisfied), or 3 (completely satisfied). The users also used this numerical ranking scheme to evaluate each PRSV's pressure[5], ability to clean dishes, and spray pattern.

Each user was also asked additional questions about each PRSV he or she tested, including what he or she liked or disliked about the PRSV, if he or she would consider purchasing it, if he or she used an always-on clamp, which foods he or she found particularly difficult to remove, and if he or she had to adjust the water temperature when using the PRSV. At the end of the study, users were allowed to choose one of the EPAct 2005-compliant PRSVs to keep.

Following the surveys and after allowing the user to select his or her preferred PRSV, ERG considered all responses—quantitative and qualitative—pertaining to PRSV performance and designated an overall satisfaction score of 1, 2, or 3 from each user for each PRSV at each facility. An example of this evaluation is shown in Table 5.

**Table 5. Example Overall User Satisfaction Score Evaluation**

| | |
|---|---|
| Facility | Harvard Currier |
| PRSV | D |
| User | User 2 |
| Overall Satisfaction Score Based on User Responses | 2 |
| How satisfied are you with the spray valve? If unsatisfied, explain. | 1 (It sprays out too much water.) |
| How satisfied are you with the spray valve's pressure? If unsatisfied, was it too strong, too weak, produced excessive backsplash, produced misting, other? | 3 (The pressure is good. I like Valve A better than Valve B.) |
| How satisfied are you with the dish sprayer's ability to clean the dishes? If unsatisfied, was it too slow, too fast, other? | 3 (Very good.) |

[5] Pressure in this context refers to the perceived force of the water spray.

**Table 5. Example Overall User Satisfaction Score Evaluation**

| | |
|---|---|
| How satisfied are you with the spray valve's spray pattern? If unsatisfactory, was it too wide, too focused, non-uniform coverage, required modified use pattern, other? | 1 (I like when it shoots out in a stream. This one is a fan.) |
| If you were making the purchasing decision, would you buy this spray valve? | Never. |
| What do you like about this spray valve? | The pressure is good. |
| What do you dislike about this spray valve? | When I move it around to clean the dishes, it sprays all over me. |

In this case, the user evaluated the PRSV as being satisfactory when prompted with questions regarding the PRSV's pressure and ability to clean dishes. However, when asked, ~~"h~~ow satisfied are you with the spray valve?" the user assigned the PRSV a 1 for unsatisfied and additionally would not purchase the PRSV if given the option. Because this user was very satisfied with several characteristics (pressure, cleaning ability) and unsatisfied with others (spray pattern), an overall user satisfaction score of 2 (somewhat satisfied) was given.

This same methodology was used to determine overall user satisfaction score for each PRSV evaluated by each user on a case-by-case basis. The overall user satisfaction scores were used to perform the user satisfaction analysis in Section 6.4.

#### *4.3.5.2 Facility Operations*

ERG asked facility managers to provide information about their establishments, such as the type of food that the establishments serve and its hours of operation. ERG also asked the facility managers to provide customer count information on a weekly basis and identify any atypical business or special events (e.g., birthday celebrations, weddings, etc.). ERG used this data to ensure that each three-week monitoring period at a facility was comparable.

A list of these facility operations questions can be found in the Pre-Rinse Spray Valves Research Study Scope in Appendix A.

## 5 Limitations

Though the study resulted in an extensive data set, EPA acknowledges the following limitations in the data collected:

- Data was collected from only 10 facilities and was limited to the Washington, D.C., and Boston, Massachusetts, areas. EPA recognizes that data from additional facilities from a broader set of locations would be valuable, but to date no additional field data have been shared.

- The only PRSVs with *ASTM F2324* test results posted on FSTC's website are those with cleanability times at or below 26 seconds per plate. Since EPA wanted to compare the posted cleanability time with other key data parameters, the PRSVs included in this study are limited to those with cleanability times below 26 seconds per plate. EPA

cannot draw any conclusions regarding PRSVs with cleanability times of more than 26 seconds per plate.

- Manual measurements (water temperature, flow rate, and water pressure) were only collected once per week during the weekly site visits. These spot measurements are not as robust as a continuous average, especially considering that a facility's water pressure and temperature may fluctuate throughout the day. However, since the data were collected each week for the three-week monitoring period, three weekly measurements were averaged to develop a more representative water temperature, flow rate, and water pressure data set for each PRSV at each facility.

- As discussed in Section 4.2, even taking into account the variability of flowing water pressure in the field, the operating flow rates achieved by PRSVs E, G, and B in the field were much higher than expected based on their tested flow rates. The operating flow rates achieved by PRSV K in the field were much lower than expected based on its tested flow rate. This is an outstanding issue that EPA will need to investigate and resolve prior to developing a specification.

- Several PRSVs malfunctioned (leaked or broke) during the three-week monitoring period. If the malfunction happened early in the monitoring period, a different PRSV was installed and the monitoring period was restarted. If the malfunction was identified after the last week of monitoring, ERG used the data in the data analysis. While EPA found that most of the malfunctions were easy to repair, EPA is still concerned with such a high malfunction rate over such a short period of time. EPA is considering whether PRSVs need to undergo rigorous life cycle testing as part of its specification.

- A language barrier at some facilities complicated the user satisfaction survey. ERG was able to overcome this obstacle by administering the survey verbally in various languages using translators where needed or by providing the written survey in non-English languages.

- The Harvard University dining hall facilities were equipped with garbage disposal troughs that use recirculated water. Though it was not evident during the initial facility selection site visit, it became apparent later that the users often used this recirculated stream of water to rinse plates and dishes instead of the PRSV. As a result, the water use at the Harvard University dining halls was low for facilities of their size and customer throughput.

- Though, in some instances, multiple users provided satisfaction survey data for a specific PRSV at a facility, EPA could not determine the specific use time from each individual user. Oftentimes, the users used the PRSV at different times during the same shift, and the data logger simply continues to record use time, without differentiation to the user. In order to log use time from individual users, continuous observation and manual logging would have been required. Therefore, EPA used the average use time calculated for each PRSV tested at each facility (which accounts for use time from all users) in its analysis of the impact of use time on user satisfaction, noting that the individual use times for each user may have been different.

# 6 Results

To provide data to support the research objectives outlined in Section 3, this section presents the water use, operating flow rate, use time, cleanability times, and user satisfaction data for the PRSVs monitored in the study, as well as an analysis of potential relationships between these parameters. Below is a brief description of each parameter:

- Water Use (gallons per day): The average daily water use of a PRSV, as calculated by dividing the total water use in gallons during the monitoring period at a given facility by the total number of days the PRSV was monitored.

- Operating Flow Rate (gpm): The average of the weekly operating flow rate measurements for a PRSV at a given facility.

- Use Time (minutes per day): The average daily use time of a PRSV, as calculated by dividing the total use time in minutes during the monitoring period at a given facility by the total number of days it was monitored.

- Cleanability Time (seconds per plate): Cleanability times, as determined by FSTC in accordance with the *ASTM F2324* test method. Cleanability times presented in this report were obtained from the FSTC website.[6] Cleanability times are rounded to the nearest whole number to mask the model names of each PRSV.

- User Satisfaction Score: The overall satisfaction score for a PRSV, as discussed in Section 4.3.5.1.

EPA determined that the most objective way to analyze the data and draw conclusions was to examine trends within a facility and compare those observed trends among those facilities. EPA used this approach to account for the variability in operating conditions, customer throughput,[7] and usage patterns among the facilities.

EPA's goal was to evaluate the key parameters for PRSVs that are currently available in the marketplace. As a result, EPA excluded from the analysis data from the five non-EPAct 2005-compliant baseline PRSVs that were monitored, because these PRSVs can no longer be purchased.

It is important to note that EPA's conclusions apply only to the set of PRSVs evaluated as part of the study and may not be applicable to all PRSVs on the market.

Table 6 provides the raw data from the EPAct 2005-compliant PRSVs monitored during the study. The data in this table are used to support the analysis presented in this section. A more comprehensive data set, the user satisfaction survey results, and the responses from the facility operations surveys are provided in Appendix D.

[6] The only results currently posted on FSTC's website are from PRSVs that achieve 26 seconds per plate or less.
[7] Customer throughput was defined as the number of customers served during each monitoring period.

**Table 6. EPAct 2005-Compliant Pre-Rinse Spray Valves Study Summary Data Set**

| Facility | PRSV [a] | Operating Flow Rate (gpm) [b] | Water Use (gallons per day) | Average PRSV Use Time (minutes per day) | User 1's User Satisfaction Score | User 2's User Satisfaction Score | Cleanability Time (seconds per plate) | Operating Static Water Pressure (psi) | Operating Flowing Water Pressure (psi) | Operating Water Temp (ºF) |
|---|---|---|---|---|---|---|---|---|---|---|
| BB&N | C | 1.29 | 97.7 | 64.3 | 3 | NA | 22 | 67 | 55 | 116.4 |
| | E | 1.54 | 119.8 | 77.6 | 1 | NA | 25 | 68 | 52 | 109.8 |
| | B | 1.57 | 105.3 | 68.1 | 1 | NA | 24 | 67 | 51 | 136.1 |
| BC McElroy | J | 0.81 | 90.9 | 111.9 | 1 | 1 | 21 | 66 | 64 | 116.0 |
| | C | 1.25 | 114.2 | 92.7 | 2 | 2 | 22 | 71 | 67 | 116.2 |
| | D | 1.53 | 153.8 | 99.8 | 2 | 3 | 21 | 72 | 64 | 117.7 |
| BC Stuart | M | 1.10 | 19.4 | 19.1 | 3 | NA | 20 | 69 | 51 | 105.1 |
| | K | 1.18 | 39.3 | 32.6 | 3 | NA | 17 | 78 | 57 | 118.3 |
| | I | 1.29 | 24.4 | 21.2 | 3 | NA | 22 | 77 | 71 | 112.3 |
| Farmers & Fishers | J | 0.79 | 168.7 | 202.2 | 1 | NA | 21 | 63 | 61 | 122.2 |
| | X | 1.17 | 199.2 | 182.5 | 2 | NA | NA | 62 | 55 | 126.1 |
| | G | 1.41 | 282.3 | 204.4 | 3 | NA | 23 | 62 | 55 | 129.2 |
| | F | 1.54 | 311.6 | 201.1 | 3 | NA | 21 | NC | NC | 127.0 |
| Founding Farmers | L | 1.07 | 234.3 | 224.9 | 2 | NA | 23 | 59 | 51 | 114.0 |
| | K | 1.10 | 198.0 | 179.7 | 3 | NA | 17 | 58 | 42 | 119.2 |
| | F | 1.19 | 191.9 | 157.2 | 3 | NA | 21 | NC | NC | 120.7 |
| | E | 1.62 | 274.5 | 176.9 | 3 | NA | 25 | 58 | 44 | 118.3 |
| Harvard Currier | J | 0.55 | 7.2 | 10.6 | 1 | 2 | 21 | 51 | 48 | 110.3 |
| | L | 1.00 | 11.0 | 11.5 | 3 | 3 | 23 | 55 | 50 | 93.2 |
| | D | 1.06 | 11.8 | 11.1 | 1 | 2 | 21 | 54 | 49 | 120.1 |
| | K | 1.08 | 12.0 | 11.4 | 3 | 3 | 17 | 52 | 48 | 99.0 |

**Table 6. EPAct 2005-Compliant Pre-Rinse Spray Valves Study Summary Data Set**

| Facility | PRSV [a] | Operating Flow Rate (gpm) [b] | Water Use (gallons per day) | Average PRSV Use Time (minutes per day) | User 1's User Satisfaction Score | User 2's User Satisfaction Score | Cleanability Time (seconds per plate) | Operating Static Water Pressure (psi) | Operating Flowing Water Pressure (psi) | Operating Water Temp (ºF) |
|---|---|---|---|---|---|---|---|---|---|---|
| Harvard Mather | N | 0.51 | 15.9 | 31.7 | 2 | NA | 21 | 41 | 38 | 119.0 |
| | A | 0.56 | 12.3 | 24.3 | 3 | NA | 21 | 50 | 46 | 120.5 |
| | K | 0.97 | 29.1 | 31.6 | 3 | NA | 17 | 50 | 41 | 104.2 |
| | F | 1.13 | 51.4 | 45.7 | 3 | NA | 21 | NC | NC | 127.0 |
| Jimmy's | A | 0.65 | 57.9 | 89.3 | 1 | NA | 21 | 62 | 57 | 86.6 |
| | I | 1.14 | 120.1 | 112.4 | 2 | 3 | 22 | 65 | 55 | 83.7 |
| | D | 1.35 | 119.9 | 94.1 | 3 | 3 | 21 | 68 | 53 | 82.6 |
| Mario's | J | 0.78 | 33.0 | 49.7 | 2 | 2 | 21 | 88 | 83 | 69.0 |
| | G | 1.75 | 71.7 | 43.3 | 3 | 3 | 23 | 91 | 73 | 85.9 |
| | F | 1.88 | 83.7 | 47.7 | 3 | 3 | 21 | 82 | 68 | 76.1 |
| The Fireplace | H | 0.86 | 66.1 | 81.0 | 1 | NA | 20 | 68 | 54 | 113.0 |
| | D | 1.04 | 80.3 | 75.7 | 3 | NA | 21 | 73 | 59 | 113.4 |
| | K | 1.09 | 82.7 | 75.4 | 3 | NA | 17 | 71 | 52 | 123.2 |
| | B | 1.46 | 82.5 | 58.2 | 3 | NA | 24 | 66 | 43 | 121.9 |

NA – Data were not available.
NC – Data were not collected.
a – PRSVs are coded to mask their model names.
b – Operating flow rate is provided in all cases where available. In cases where operating flow rate data were not available, maximum flow rate was used.

## 6.1 Water Use

The WaterSense program labels products that use at least 20 percent less water than standard models. As discussed in Section 1, stakeholders were concerned that water savings from high-efficiency PRSVs might be offset by users spending more time using the PRSVs to remove food waste from dishes. To examine this issue, EPA evaluated the relationship between water use and PRSV operating flow rates.

As shown in Figure 2, EPA plotted the water use of each PRSV installed at each facility against its corresponding operating flow rate. The resulting graph provides a single data point for each EPAct 2005-compliant PRSV tested at each facility. The data points from each facility are connected with a solid line.

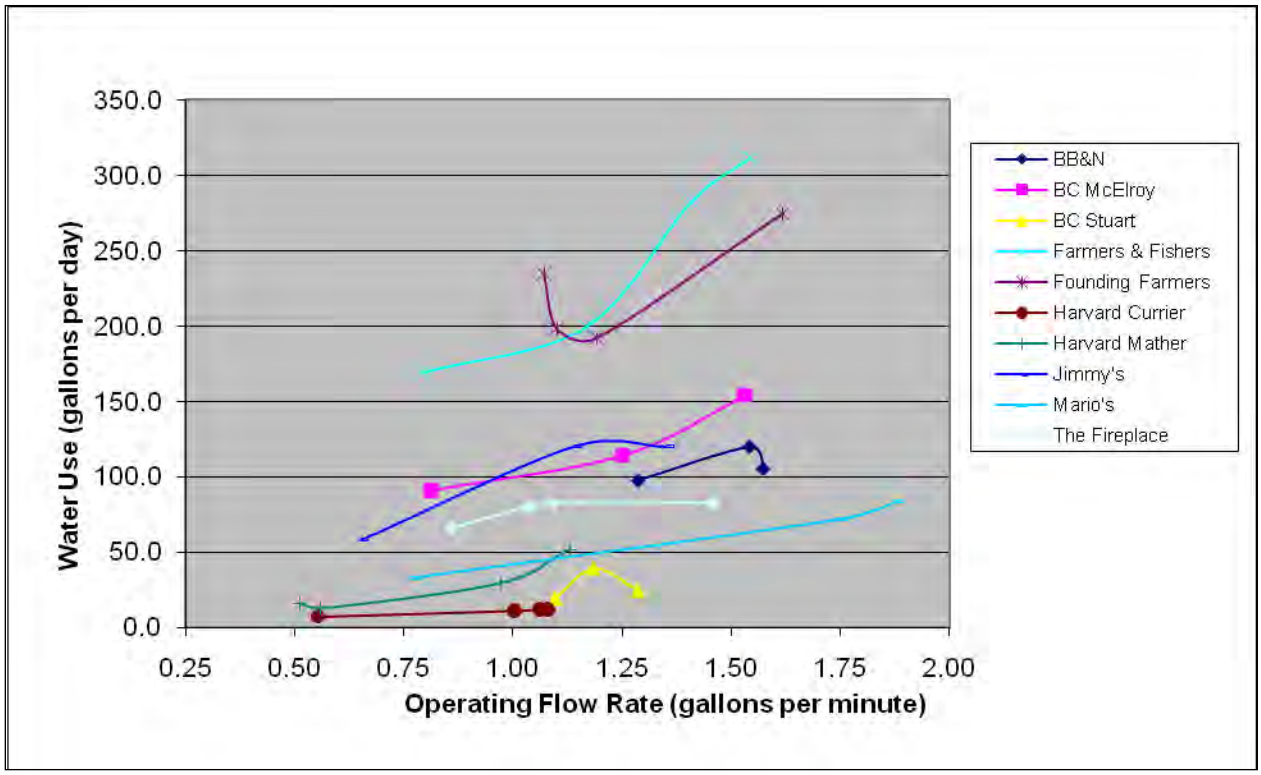


**Figure 2. Water Use vs. Operating Flow Rate**

Figure 2 shows that, in general, water use decreases when high-efficiency PRSVs are used (i.e., the lines slope downward to the left), although the relationships do not appear to be fully linear. Because high-efficiency PRSVs use less water, this indicates that use time does not increase such that it completely offsets expected water savings.

## 6.2 Use Time

To further address its concern that use time increases with the use of high-efficiency PRSVs, EPA examined the relationship between use time and PRSV operating flow rates.

As shown in Figure 3, EPA plotted the use time of each PRSV installed at each facility against its corresponding operating flow rate. The resulting graph provides a single data point for each EPAct 2005-compliant PRSV tested at each facility. The data points from each facility are connected with a solid line.

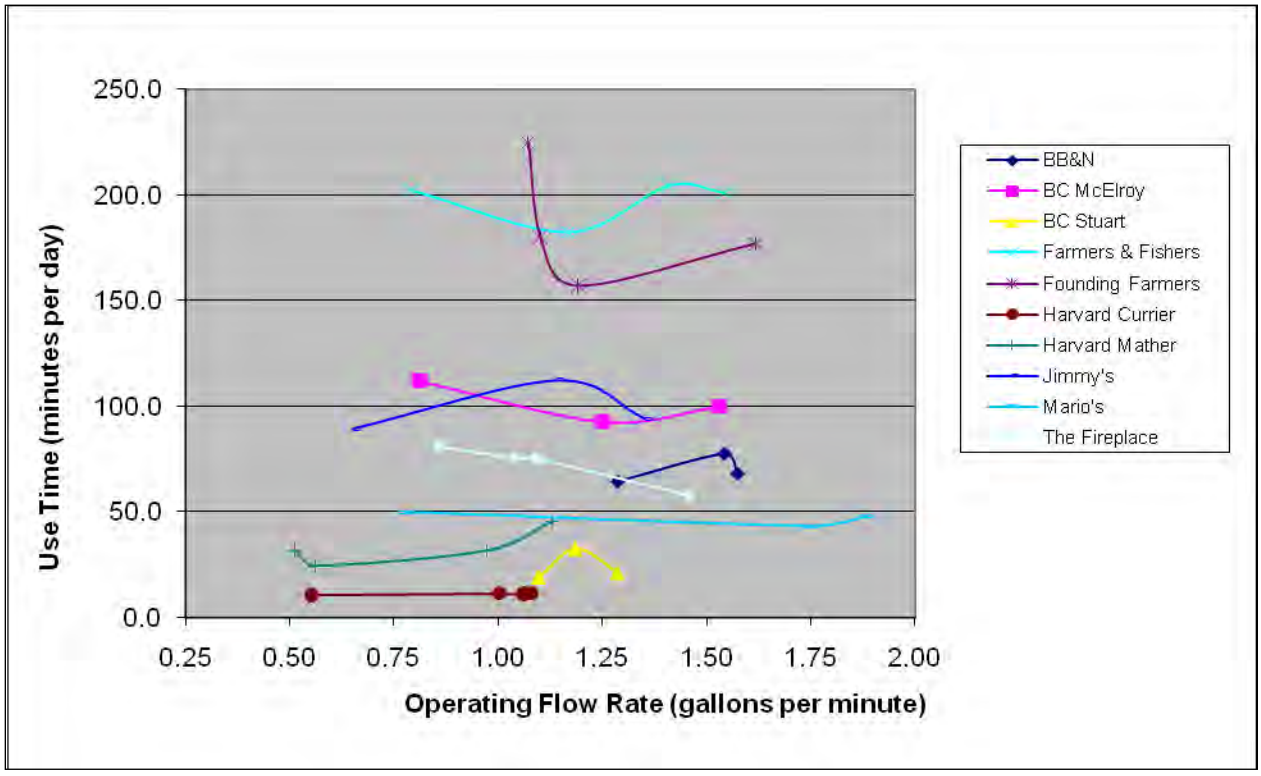


**Figure 3. Use Time vs. Operating Flow Rate**

While the relationships between PRSV operating flow rate and use time are not consistent from facility to facility, Figure 3 indicates that in, general, use time tends to remain relatively constant regardless of the PRSV's operating flow rate. In other words, high-efficiency PRSVs are not consistently used longer than standard PRSVs.

### 6.3 Cleanability Time

As discussed in Section 1, EPA was concerned that cleanability time may not accurately indicate whether a user will operate a PRSV for more time in the field. To examine this issue, EPA evaluated the relationship between use time and cleanability time.

As shown in Figure 4, EPA plotted use time for each PRSV tested at each facility against its corresponding cleanability time. The resulting graph provides a single data point for each EPAct 2005-compliant PRSV tested at each facility. The data points from each facility are connected with a solid line.

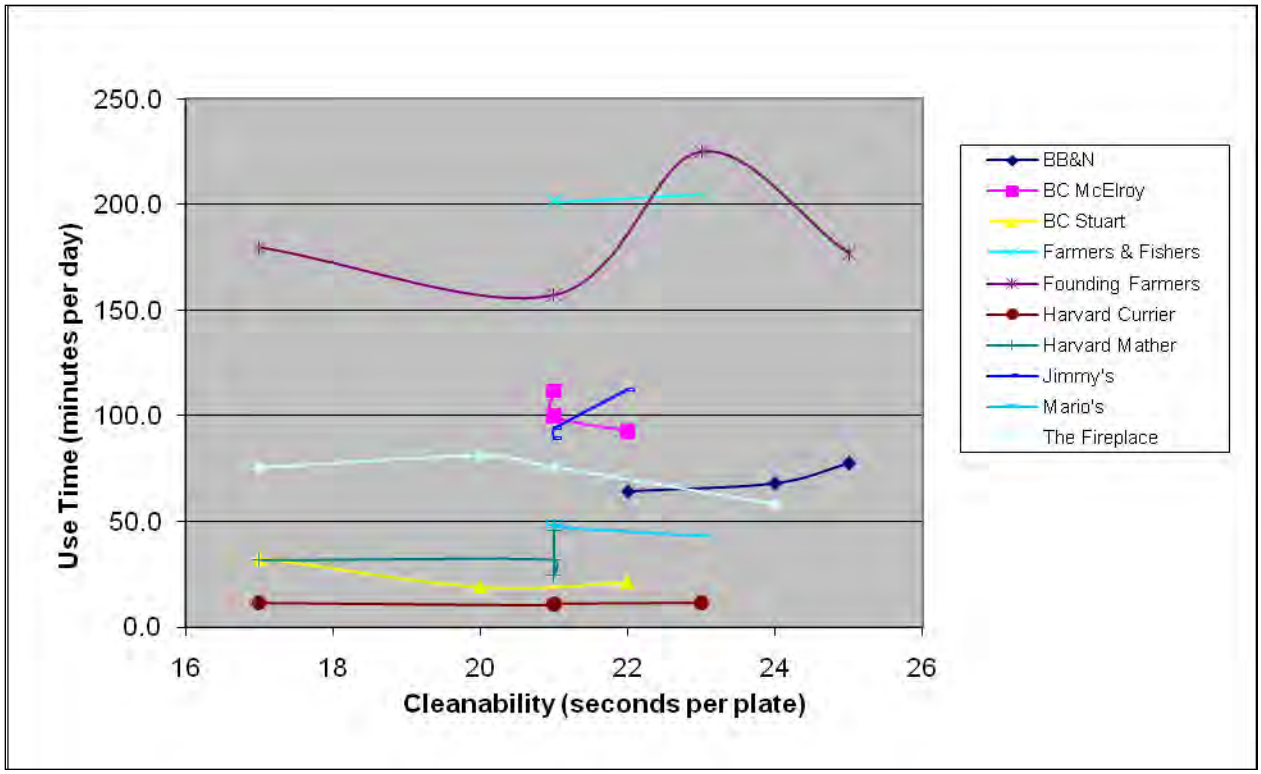


**Figure 4. Use Time vs. Cleanability Time**

Figure 4 shows that as the cleanability time increases, in general, use time remains relatively constant. Therefore, cleanability time is not an indicator of the amount of time the PRSV is used in the field for those PRSVs monitored in the study. It is important to point out that this data set and conclusions are limited to the PRSVs that were tested, which all had cleanability times of 26 seconds per plate or less. EPA cannot draw any conclusions about the relationship between cleanability times and use time for PRSVs that have cleanability times greater than 26 seconds per plate.

## 6.4 User Satisfaction

The WaterSense program labels products that not only save water but also perform as well as or better than standard models. As indicated in Section 1, stakeholders were concerned about the performance of high-efficiency PRSVs, particularly those with flow rates less than 1.0 gpm. To address this issue, EPA sought to determine whether operating flow rate, use time, or cleanability time influences user satisfaction.

### *6.4.1 User Satisfaction and Flow Rate*

To determine if users are less satisfied with high-efficiency PRSVs, particularly those with operating flow rates less than 1.0 gpm, EPA compared the user satisfaction score for each PRSV to its corresponding operating flow rate.

To facilitate the analysis, EPA grouped the PRSVs into the categories described in Section 4.2 based on their operating flow rates instead of their tested flow rates. Since the operating flow rate in the field differed from the tested flow rate for a PRSV (as discussed in Section 4.2), and since users were evaluating the PRSVs in the field and not in a laboratory setting, EPA grouped the PRSVs by operating flow rate in this analysis. Figure 5 shows how often the users rated the PRSVs in each flow rate category as satisfactory, somewhat satisfactory, or completely satisfactory.

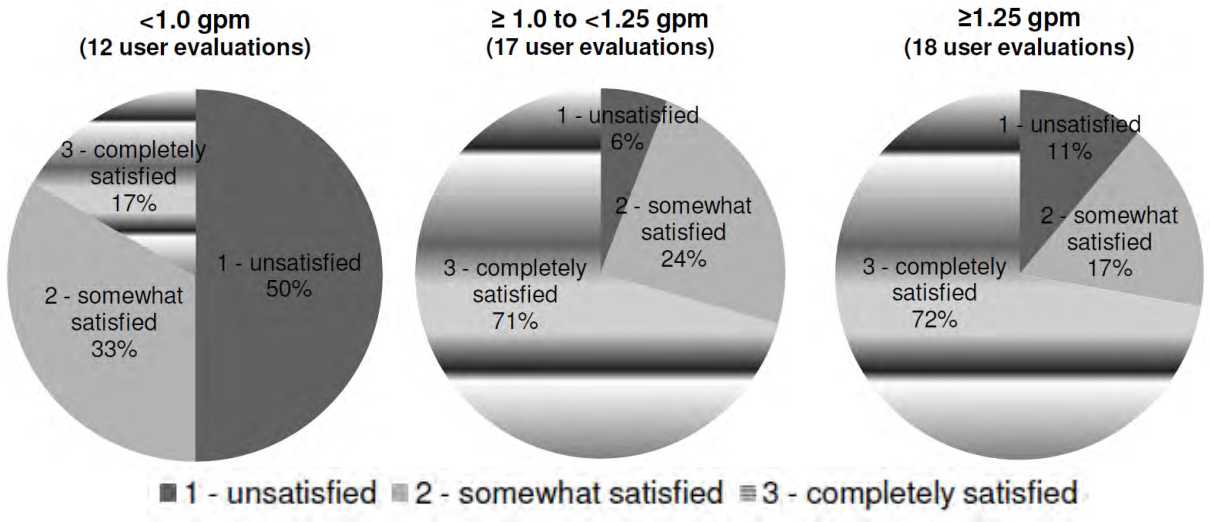


**Figure 5. Frequency of User Satisfaction Scores Among EPAct 2005-Compliant PRSV Categories (Categorized Using Operating Flow Rate)**

Figure 5 indicates that users were generally more satisfied with the performance of PRSVs with operating flow rates higher than 1.0 gpm.

### *6.4.2 User Satisfaction and Use Time*

Though use time remained relatively constant, as discussed in Section 6.2, EPA evaluated if even small changes in use time impacted user satisfaction. EPA calculated the average use time for all of the EPAct 2005-compliant PRSVs at each facility and compared this average to the use time and associated user satisfaction score for each individual PRSV at the facility, as shown in Table 7.

**Table 7. Average Use Time per PRSV, Facility Average Use Time, and User Satisfaction per PRSV**

| Facility | PRSV | User 1's User Satisfaction Score | User 2's User Satisfaction Score | Average PRSV Use Time (minutes per day) | Facility Average Use Time (minutes per day) |
|---|---|---|---|---|---|
| BB&N | C | 3 | NA | 64.3 | 70.0 |
| | B | 1 | NA | 68.1 | |
| | E | 1 | NA | 77.6 | |

**Table 7. Average Use Time per PRSV, Facility Average Use Time, and User Satisfaction per PRSV**

| Facility | PRSV | User 1's User Satisfaction Score | User 2's User Satisfaction Score | Average PRSV Use Time (minutes per day) | Facility Average Use Time (minutes per day) |
|---|---|---|---|---|---|
| BC McElroy | C | 2 | 2 | 92.7 | |
| | D | 2 | 3 | 99.8 | |
| | J | 1 | 1 | 111.9 | 101.5 |
| BC Stuart | M | 3 | NA | 19.1 | |
| | I | 3 | NA | 21.2 | |
| | K | 3 | NA | 32.6 | 24.3 |
| Farmers & Fishers | X | 2 | NA | 182.5 | |
| | F | 3 | NA | 201.1 | |
| | J | 1 | NA | 202.2 | |
| | G | 3 | NA | 204.4 | 197.5 |
| Founding Farmers | F | 3 | NA | 157.2 | |
| | E | 3 | NA | 176.9 | |
| | K | 3 | NA | 179.7 | |
| | L | 2 | NA | 224.9 | 184.7 |
| Harvard Currier | J | 1 | 2 | 10.6 | |
| | D | 1 | 2 | 11.1 | |
| | K | 3 | 3 | 11.4 | |
| | L | 3 | 3 | 11.5 | 11.2 |
| Harvard Mather | A | 3 | NA | 24.3 | |
| | K | 3 | NA | 31.6 | |
| | N | 2 | NA | 31.7 | |
| | F | 3 | NA | 45.7 | 33.4 |
| Jimmy's | A | 1 | NA | 89.3 | |
| | D | 3 | 3 | 94.1 | |
| | I | 2 | 3 | 112.4 | 98.6 |
| Mario's | G | 3 | 3 | 43.3 | |
| | F | 3 | 3 | 47.7 | |
| | J | 2 | 2 | 49.7 | 46.9 |
| The Fireplace | B | 3 | NA | 58.2 | |
| | K | 3 | NA | 75.4 | |
| | D | 3 | NA | 75.7 | |
| | H | 1 | NA | 81.0 | 72.6 |

NA – Data were not available.

To determine if the time differential between the facility's average use time and the PRSV's use time impacted user satisfaction, using the data in Table 7, EPA prepared Figure 6, which shows when the PRSVs were used for more or less time than the average at a facility and how often the users rated the PRSVs as unsatisfactory, somewhat satisfactory, or completely satisfactory under both scenarios.

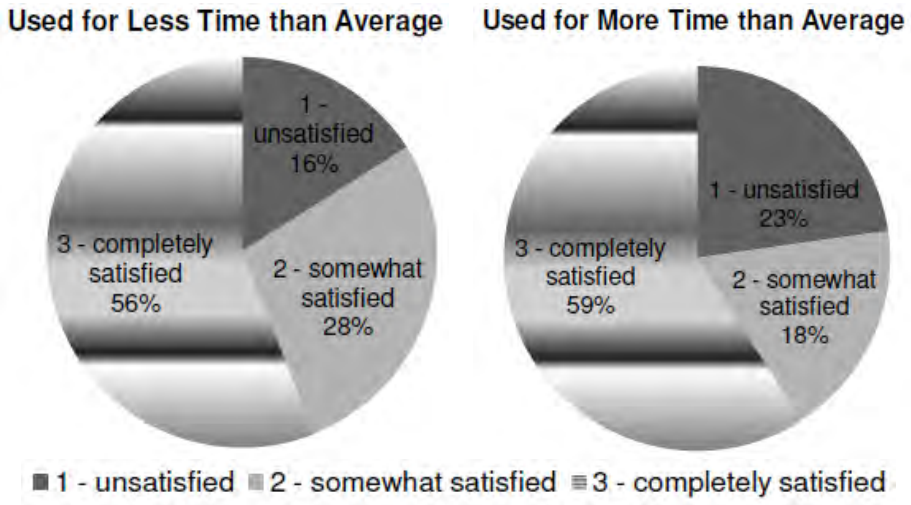


**Figure 6. Frequency of Satisfaction Score Occurrence for PRSVs With More or Less Than the Average Use Time at a Facility**

Figure 6 shows that there is no relationship between user satisfaction and an increase or decrease in use time for the EPAct 2005-compliant PRSVs tested in this study. PRSVs that were used for more time than average were not rated less satisfactory more often than those that were used for less time. Nor were the PRSVs that were used for less time than the average rated more satisfactorily more frequently than those used for more time. Though these results indicate that the relative change in use time did not impact user satisfaction in this study, it may be because use time remained relatively constant among the PRSVs tested and users could not perceive a difference in the amount of time they used each PRSV.

### *6.4.3 User Satisfaction and Cleanability Time*

To determine if cleanability time can be used to indicate performance, EPA compared the user satisfaction score from each user that tested each PRSV with its corresponding cleanability time, as shown in Figure 7.

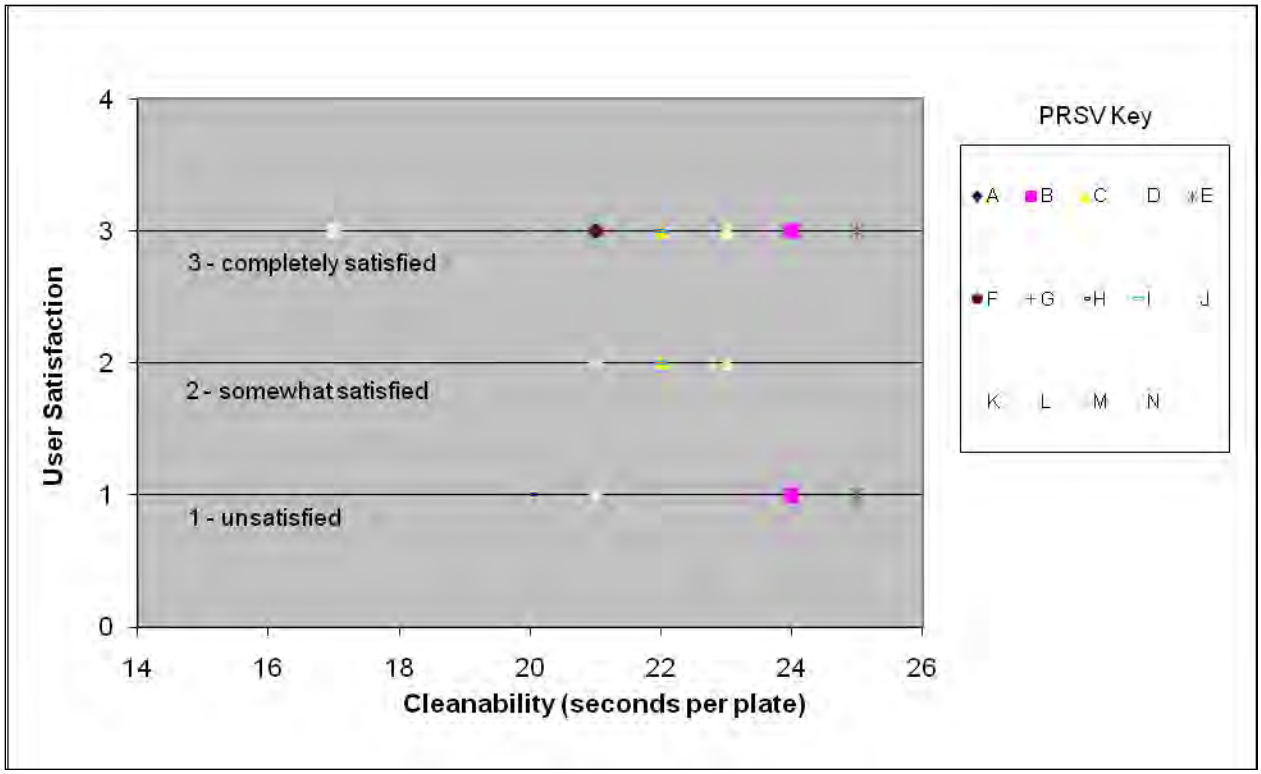


**Figure 7. User Satisfaction Vs. Cleanability Time**

As shown in Figure 7, many PRSVs with the same cleanability time received different user satisfaction scores. Further, there was no clear preference for PRSVs with the lowest cleanability times, nor less preference for PRSVs with the highest cleanability times. Therefore, cleanability time does not appear to differentiate PRSV performance for the PRSVs tested. It is important to point out that this data set and conclusions are limited to the PRSVs that were tested, which all had cleanability times posted on the FSTC website of 26 seconds per plate or less. EPA cannot draw any conclusions about the relationship between cleanability times and user satisfaction for PRSVs that have cleanability times greater than 26 seconds per plate.

### *6.4.4 User Satisfaction and Other Performance Characteristics*

The WaterSense program develops specifications to not only differentiate water efficiency but also performance of the products it labels. To evaluate what performance characteristics may impact user satisfaction, EPA analyzed user responses to survey questions for PRSVs receiving an overall user satisfaction rating of 1, meaning the users were unsatisfied. There were a total of 56 overall user satisfaction scores, of which nine were unsatisfactory. Feedback on the performance of the unsatisfactory PRSVs is summarized in Table 8.

For these unsatisfactory scores, four out of the nine were attributed to spray pattern, among other factors. User preference for spray pattern was user-specific. For example, in Table 8, multiple users evaluated PRSV J and had varying levels of satisfaction for its spray pattern.

Seven out of the nine unsatisfactory scores were attributed to the ability to clean, among other factors. Users commonly cited the cleaning ability as ~~"t~~oo slow." From this feedback, EPA determined that users were concerned with what they perceived to be increased use time. EPA analyzed use time in relation to user satisfaction in detail in Section 6.4.2 and determined that there was no relationship between user satisfaction and use time, likely because the time PRSVs were in use remained relatively constant.

Seven out of the nine unsatisfactory scores were also attributed to pressure, or the user perceived force of the spray, among other factors. Most of the users indicated that weak pressure was an issue. However, one user was unsatisfied due to backsplash, which may have been a result of high pressure. Since several users indicated pressure (i.e., spray force) as a reason for dissatisfaction, pressure may be a factor that EPA should consider for differentiating PRSV performance.

EPA also considered qualitative feedback regarding what users liked or disliked about PRSVs. Of the overall unsatisfactory scores, one user identified design characteristics as being unsatisfactory. This user found that it was difficult to fully engage and hold down the PRSV handle. Other users commented on design, as well, when asked what they did not like about the PRSV; however, user satisfaction for PRSV design varied.

**Table 8. User Satisfaction Feedback for Unsatisfactory PRSVs**

| Facility | User | Operating Flow Rate (gpm) | How satisfied are you with the spray valve? | How satisfied are you with the spray valve's pressure?[8] | How satisfied are you with the dish sprayer's ability to clean dishes? | How satisfied are you with the spray valve's spray pattern? | What do you like about this spray valve? | What do you dislike about this spray valve? |
|---|---|---|---|---|---|---|---|---|
| **PRSV D, Shower Spray Pattern** | | | | | | | | |
| Harvard Currier | User 1 | 1.06 | 1 (This spray valve tends to break easy. One is already leaking. Too much water comes out and it sprays right back at you.) | 1 (It produces backsplash. In the past when I've tried this valve it has been known to use more water.) | 1 (The water comes out too fast.) | 1 (It comes out weird. Each hole leads to water coming out in a criss-cross pattern.) | Nothing. | The spray back. |
| **PRSV B, Fan Spray Pattern** | | | | | | | | |
| BB&N | User 1 | 1.57 | 1 | 1 - It's very weak. He wants a jet spray. This one is more of a showerhead. He wants a direct, powerful spray. He has to work at cleaning the dishes. | 1 - Too slow. | 1 - If there was more pressure, the spray pattern would be fine. It is a bit too wide. It should be a jet stream. It is hard to spray into the dishwasher to clean it off. | Nothing. | The pressure, the spray pattern because it's too wide (but it would be better if it had better pressure, the splash back when filling a bucket. He feels he can't do his job as well.) |

[8] Pressure in this context refers to the perceived force of the water spray.

**Table 8. User Satisfaction Feedback for Unsatisfactory PRSVs**

| Facility | User | Operating Flow Rate (gpm) | How satisfied are you with the spray valve? | How satisfied are you with the spray valve's pressure?[8] | How satisfied are you with the dish sprayer's ability to clean dishes? | How satisfied are you with the spray valve's spray pattern? | What do you like about this spray valve? | What do you dislike about this spray valve? |
|---|---|---|---|---|---|---|---|---|
| **PRSV E, Fan Spray Pattern** | | | | | | | | |
| BB&N | User 1 | 1.54 | 0 (Terrible. Worse pressure than the last one. Pressure is key to my job.) | 0 (Too weak, extremely weak.) | 0 (Too slow. Dishes are dirty when they come out of the dishwasher and I have to re-rinse a lot with this spray valve. I feel like I am using more water because it takes me longer. I am not able to do my job.) | 1.5 (The spray pattern doesn't matter to me if there is pressure. A direct spray would be better, but spray pattern is not that important. It's hard to get stuff that is stuck on and hard to clean far places.) | Nothing. The spray pattern is fine but the ideal is a straight spray like a showerhead with the massage setting. | I don't like the pressure and the ability to clean. I don't like everything. |
| **PRSV H, Jet Spray Pattern** | | | | | | | | |
| The Fireplace | User 1 | 0.86 | 1 | 3 | 3 | 3 | It's strong. | The spray is very straight. |

**Table 8. User Satisfaction Feedback for Unsatisfactory PRSVs**

| Facility | User | Operating Flow Rate (gpm) | How satisfied are you with the spray valve? | How satisfied are you with the spray valve's pressure?[8] | How satisfied are you with the dish sprayer's ability to clean dishes? | How satisfied are you with the spray valve's spray pattern? | What do you like about this spray valve? | What do you dislike about this spray valve? |
|---|---|---|---|---|---|---|---|---|
| **PRSV J, Jet Spray Pattern** | | | | | | | | |
| BC McElroy | User 1 | 0.81 | 1 (There is no pressure. This has the best design. The spray angle and pattern are good.) | 1 (Too weak.) | 1 (Too slow, it took longer to clean the plates.) | 3 | I like the spray pattern, the handle with the always-on clamp, and how it is small. I like the design. | I do not like the pressure- that is the main thing. It felt like it took longer to clean the plates. |
| BC McElroy | User 2 | 0.81 | 1 (It has no power or pressure.) | 1 (I have to get right on the plate or scrub to get the food off. The pressure is too weak.) | 1 (It took too long to clean the plates. I like the design, the always-on clamp, because it gives my wrist a rest.) | 3 (I am able to direct the spray right where I want it to go because it is a straight spray pattern. I don't like the fan spray.) | I like the design, the always-on clamp, and the spray pattern. | There is no pressure or power. |
| Farmers & Fishers | User 1 | 0.79 | 1 | 2 (A little weak.) | 2 | 3 | I like that the trigger can be locked into place. | It is difficult to fully engage and hold down the handle. |

**Table 8. User Satisfaction Feedback for Unsatisfactory PRSVs**

| Facility | User | Operating Flow Rate (gpm) | How satisfied are you with the spray valve? | How satisfied are you with the spray valve's pressure?[8] | How satisfied are you with the dish sprayer's ability to clean dishes? | How satisfied are you with the spray valve's spray pattern? | What do you like about this spray valve? | What do you dislike about this spray valve? |
|---|---|---|---|---|---|---|---|---|
| Harvard Currier | User 1 | 0.55 | 1 - It comes out different. Weaker. It seems like it is spitting out water. It is not a solid stream. | 1 - It is too weak. | 1 - It is too slow. It felt like it took longer to clean the dishes. | 1 - It is non-uniform. It splits and is not a solid stream. | The color. | He didn't like the way the water came out. It seems like it takes longer for it to come out. |
| **PRSV A, Fan Spray Pattern** | | | | | | | | |
| Jimmy's | User 1 | 0.65 | 1 | 1 | 1 | 2 | No good, no pressure. | No pressure. |

## 7 Water and Energy Savings Potential

The results of the study can also be used to estimate the water and energy savings that can be expected from replacing a standard PRSV with a high-efficiency PRSV. Because facility characteristics, specifically customer throughput, determine the total water use of a facility, a wide range of water and energy savings can be expected.

Table 9 presents the assumptions used to calculated energy use and savings. Table 10 presents the calculated annualized water and energy savings that can be expected at each of the facilities from replacing the standard Category 1 PRSV that was monitored with high-efficiency PRSVs monitored from Category 2 (tested flow rate of 1.0 to 1.25 gpm) and Category 3 (tested flow rate less than 1.0 gpm). For facilities with an existing PRSV that did not comply with EPAct 2005, even greater savings can be expected, as shown in Table 11.

**Table 9. Energy Use Assumptions and Calculations**

| Source of Energy to Heat Water | Energy Use Assumptions |
|---|---|
| Electricity | Calculate how many kilowatt-hours (kWh) of electricity are required to heat a gallon of water, assuming:<br>• Specific heat of water = 1.0 British thermal unit (Btu)/pound (lb) ºF<br>• 1 gallon of water = 8.34 lbs<br>• 1 kWh = 3,412 Btu<br>• Incoming water temperature raised from facility cold water temperature (ºF) to operating temperature (ºF) (Δ ºF)<br>• Water heating process is 90 percent efficient, electric hot water heater |
| | $\frac{\left[(1\,\text{gallon})\left(\frac{1.0\,\text{BTU}}{(1\,\text{lb})(1°\text{F})}\right)\left(\frac{1\,\text{kWh}}{3{,}412\,\text{Btu}}\right)\left(\frac{8.34\,\text{lbs}}{1\,\text{gallon}}\right)(\Delta\,°\text{F})\right]}{0.90} = \text{kWh/gallon}$ |
| Natural Gas | Calculate how many thousand cubic feet (Mcf) of natural gas are required to heat 1,000 gallons of water, assuming:<br>• Specific heat of water = 1.0 Btu/lb º F<br>• 1 gallon of water = 8.34 lbs<br>• 1 Therm = 99,976 Btu<br>• Incoming water temperature raised from facility cold water temperature (ºF) to facility operating temperature (ºF) (Δ º F)<br>• Water heating process is 60 percent efficient, natural gas hot water heater |
| | $\frac{\left[(1\,\text{gallon})\left(\frac{1.0\,\text{Btu}}{(1\,\text{lb})(1°\text{F})}\right)\left(\frac{1\,\text{Therm}}{99{,}976\,\text{Btu}}\right)\left(\frac{8.34\,\text{lbs}}{1\,\text{gallon}}\right)(\Delta\,°\text{F})\right]}{0.60} = \text{kWh/gallon}$<br><br>$\left(\frac{\text{Therms}}{1\,\text{gallon}}\right)(1{,}000\,\text{gallons})\left(\frac{1\,\text{Mcf}}{10{,}307\,\text{Therms}}\right) = \frac{\text{Mcf}}{\text{kgal}}$ |

## Table 10. Estimated Savings From Replacing Category 1 Pre-Rinse Spray Valves[9]

| | Annual Water Use (gallons)[10] | | | Annual Savings[11] | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Replacing Category 1 PRSV With Category 2 PRSV | | | Replacing Category 1 PRSV With Category 3 PRSV | | |
| | Category 1 (tested flow rate of 1.25 to 1.6 gpm) | Category 2 (tested flow rate of 1.0 to 1.25 gpm) | Category 3 (tested flow rate less than 1.0 gpm) | Water (gallons) | Electric (kWh) | Natural Gas (Mcf) | Water (gallons) | Electric (kWh) | Natural Gas (Mcf) |
| **Educational Facilities** | | | | | | | | | |
| BC Stuart | 9,800 | 6,100 | 4,800 | 3,700 | 400 | 2.0 | 5,000 | 800 | 4.0 |
| BC McElroy | 38,000 | 29,000 | 23,000 | 9,900 | 1,600 | 7.8 | 16,000 | 2,700 | 14 |
| Harvard Mather | 7,300–13,000 | *N/A* | 3,100–4,000 | *N/A* | *N/A* | *N/A* | 3,300–9,800 | 500–1,900 | 2.5–9.3 |
| Harvard Currier | 3,000–3,000 | 2,700 | 1,800 | 210–250 | 68–240 | 0.3–1.2 | 1,200–1,200 | 130–290 | 0.6–1.5 |
| BB&N | *N/A* | 17,000–18,000 | 20,000 | *N/A* | *N/A* | *N/A* | *N/A* | *N/A* | *N/A* |

[9] Due to equipment malfunctions and other site conditions, some facilities were not able to test a PRSV in each of the flow rate categories. These instances are denoted with —N/A.For facilities where multiple PRSVs from the same category were installed, a range of water use and savings is given. BB&N did not test a Category 1 PRSV, so expected savings cannot be calculated for the scenarios provided in this table.
[10] As the table shows, water use varied widely by facility. For specific notes and caveats that may explain each facility's water use, refer to the full data set provided in Appendix D.
[11] In some instances, expected water and energy use increased. For these sites, site-specific factors should be considered (notes and caveats are discussed with the full data set in Appendix D). In addition, some of the PRSVs flowed well above their expected flow rates, as discussed further in Section 2.2. A combination of these factors may explain some of the negative savings results.

## Table 10. Estimated Savings From Replacing Category 1 Pre-Rinse Spray Valves[9]

| | Annual Water Use (gallons)[10] | | | Annual Savings[11] | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Replacing Category 1 PRSV With Category 2 PRSV | | | Replacing Category 1 PRSV With Category 3 PRSV | | |
| | Category 1 (tested flow rate of 1.25 to 1.6 gpm) | Category 2 (tested flow rate of 1.0 to 1.25 gpm) | Category 3 (tested flow rate less than 1.0 gpm) | Water (gallons) | Electric (kWh) | Natural Gas (Mcf) | Water (gallons) | Electric (kWh) | Natural Gas (Mcf) |
| **Restaurants** | | | | | | | | | |
| Farmers & Fishers | 110,000 | 72,000–100,000 | 61,000 | 11,000–40,000 | 910–16,000 | 4.5–5.5 | 51,000 | 10,000 | 50 |
| Mario's [a] | 30,000 | 26,000 | 12,000 | 4,300 [b] | - 750 [b] | -3.7 [b] | 18,000 | 1,200 | 6.0 |
| Jimmy's | 43,000 | 43,000 | 21,000 | -89 [b] | 790 [b] | 3.9 [b] | 22,000 | 1,400 | 6.8 |
| The Fireplace [a] | 29,000–30,000 | 30,000 | 24,000 | -780–100 [b] | 420–520 [b] | 2.1–2.6 [b] | 5,100–6,000 | 1,600–1,700 | 7.7–8.3 |
| Founding Farmers [a] | 69,000–71,000 | 84,000 | 99,000 | -15,000–-13,000 | -580–470 [b] | -2.9–2.3 [b] | -30,000–-28,000 [b] | -1,400–-390 [b] | -7.1–-1.9 [b] |

a – Even taking into account the variability of flowing water pressure in the field, the operating flow rates for PRSVs E, G, and B were much higher than expected based on their tested flow rates. The operating flow rate for PRSV K was much lower than expected. As a result, these PRSVs actually flowed outside of their original designated flow rate category. Because they flowed outside of their flow rate category but are used here within that original category, negative water and energy savings may be observed when comparing these PRSVs with those in other categories.
b – Energy use was calculated based on the actual temperature change required to heat the cold water to the operating temperature at a facility; the operating temperature was often different for each PRSV. Because the temperature differential was not always consistent among the PRSVs tested at each facility, in some cases water was saved, but energy was not, and in other cases, energy was saved, while water was not.

**Table 11. Estimated Savings from Replacing Non-EPAct-Complaint Pre-Rinse Spray Valves[12,13]**

| | Annual Water Use (gallons)[14] | | | Annual Savings | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Replacing Non-EPAct PRSV With Category 2 PRSV | | | Replacing Non-EPAct PRSV With Category 3 PRSV | | |
| | Non-EPAct-Compliant (less than 1.6 gpm) | Category 2 (tested flow rate of 1.0 to 1.25 gpm) | Category 3 (tested flow rate less than 1.0 gpm) | Water (gallons) | Electric (kWh) | Natural Gas (Mcf) | Water (gal) | Electric (kWh) | Natural Gas (Mcf) |
| BC Stuart | 13,000 | 6,100 | 4,800 | 6,400 | 280 | 1.4 | 7,700 | 680 | 3.4 |
| BC McElroy | 77,000 | 29,000 | 23,000 | 49,000 | 7,800 | 39 | 55,000 | 9,000 | 45 |
| Mario's | 53,000 | 26,000 | 12,000 | 27,000 | 3,000 | 15 | 41,000 | 5,000 | 25 |
| Jimmy's | 90,000 | 43,000 | 21,000 | 47,000 | 3,500 | 17 | 70,000 | 4,100 | 20 |
| BB&N | 35,000 | 17,000–18,000 | 20,000 | 17,000–18,000 | 2,500–4,000 | 12–20 | 14,000 | 3,500 | 17 |

[12] Due to equipment malfunctions and other site conditions, some facilities were not able to test a PRSV in each of the flow rate categories. For facilities where multiple PRSVs from the same category were installed, a range of water use and savings is given.
[13] Only five facilities had non-EPAct-compliant PRSVs as baseline PRSVs.
[14] As the table shows, water use varied widely by facility. For specific notes and caveats that may explain each facility's water use, refer to the full data set provided in Appendix D.

# 8 Conclusions and Next Steps

EPA conducted this field study to better understand and characterize the performance and user satisfaction associated with high-efficiency PRSVs in order to ensure that these products, if they were to earn a WaterSense label, will be able to deliver water and energy savings.

Specifically, EPA evaluated whether water savings from high-efficiency PRSVs are offset by users requiring more time to remove food waste from dishes. In addition, EPA evaluated whether the *ASTM F2324* performance test could be applied to indicate relative use time of PRSVs in the field or to indicate user satisfaction.

After analyzing the data, EPA was able to evaluate the issues outlined in Section 3 and draw the following conclusions. EPA's conclusions only apply to the PRSVs evaluated during the study and are not necessarily applicable to all PRSVs on the market.

*Water Savings and Use Time*

Conceptually, high-efficiency PRSVs are expected to use fewer gallons of water per minute, which should result in less water use. However, an outstanding question that EPA sought to answer was whether the expected savings from the lower flow rates are completely offset by an increase in the amount of time users must spend to rinse the dishes.

EPA found that high-efficiency PRSVs used less total water than the standard models tested. In addition, the time the PRSV models were used remained relatively constant, regardless of the flow rate of the PRSVs tested. The findings indicated that, in general, high-efficiency PRSVs saved water and did not require additional use time, thus not completely offsetting expected water savings.

*Cleanability Time*

EPA also sought to determine whether the *ASTM F2324* cleanability test method accurately reflects use time in the field and whether it is a viable test for PRSV performance.

As PRSV cleanability times increased, the amount of time the PRSVs were used remained relatively constant, indicating that cleanability time was not related to the PRSVs' actual use time in the field. From this data, EPA concluded that, for the PRSVs tested, cleanability time does not accurately depict whether a user will spend more time using a PRSV.

Although the *ASTM F2324* test method was originally developed to differentiate products that use a flow restrictor to reduce flow rate without regard to performance, some groups are using it as a method to further differentiate product performance, and have specified maximum cleanability thresholds ranging from 21 to 30 seconds per plate, as discussed in Section 1. For the PRSVs evaluated in this study, which had cleanability times less than 26 seconds per plate, EPA has determined that the *ASTM F2324* test method does not provide further performance differentiation. This was evident as users did not indicate a clear preference for specific PRSVs based upon their cleanability times.

EPA wants to be clear that it cannot draw any conclusions from this study about the relationship between cleanability times and use time in the field for PRSVs that have cleanability times

greater than 26 seconds per plate. Therefore, EPA cannot determine if the cleanability time requirements greater than or equal to 26 seconds per plate, as established by some groups, differentiate performance among PRSVs and reflect actual use time in the field. Consistent with its original intent, *ASTM F2324* may be effective in differentiating products that use a flow restrictor to reduce flow rate without regard to performance, if these products generally have cleanability times greater than or equal to 26 seconds per plate.

*User Satisfaction*

In addition to understanding the water use and use time associated with high-efficiency PRSVs and the viability of the *ASTM F2324* cleanability test method to differentiate PRSV performance, EPA evaluated user feedback to determine what factors influence user satisfaction. EPA sought to understand whether users were less satisfied with high-efficiency PRSVs, PRSVs that require users to spend more time rinsing dishes, or PRSVs that had higher cleanability times.

There was no relationship between user satisfaction and use time for the EPAct 2005-compliant PRSVs tested in this study, likely because the time PRSVs were in use remained relatively constant among the EPAct 2005-compliant PRSVs at each facility. The PRSVs that were used for more time than average were not rated less satisfactory more frequently than those that were used for less time. Nor were the PRSVs that were used for less time rated more satisfactory more frequently than those used for more time.

Among the PRSVs tested, EPA found no relationship between user satisfaction and cleanability times, indicating that cleanability time is not an indicator of performance for the PRSVs tested. Cleanability time does not further differentiate PRSV performance below the threshold of the products tested (26 seconds per plate).

In general, users were less satisfied with the performance of PRSVs with operating flow rates lower than 1.0 gpm. Although the data led EPA to this conclusion in this study, flow rate may not be the sole performance indicator for this product category.

User satisfaction findings related to spray pattern and product design were user-specific. Since several users indicated pressure (i.e., spray force) as a reason for dissatisfaction, pressure may be a factor that EPA should consider for differentiating PRSV performance. Currently, there is no laboratory test method for measuring PRSV spray force.

*Summary*

Collectively, the study results indicate that high-efficiency PRSVs use less water and energy. EPA found that the *ASTM F2324* cleanability test did not indicate which of the PRSVs tested the users preferred, nor was it an indicator of actual use time in the field. EPA also found that users were less satisfied with PRSVs that flowed at less than 1.0 gpm. However, EPA concluded that use time did not have a perceivable impact on user satisfaction in this study, which may be because use time remained relatively constant among the PRSVs tested and users could not perceive a difference in the amount of time they used each PRSV. Since several users indicated pressure (i.e., spray force) as a reason for dissatisfaction, pressure may be a factor that EPA should consider for differentiating PRSV performance.

Because PRSVs have demonstrated significant water and energy savings potential, EPA will continue working with stakeholder groups to identify and develop requirements that high-efficiency PRSVs must meet in order to provide the expected performance. In addition, EPA will evaluate other issues that became apparent throughout the study, such as addressing PRSV life cycle testing and determining why some PRSVs may have operating flow rates far different than their flow rates tested using the *ASTM F2324* test method. EPA's ultimate goal is to create a specification that ensures long-term water and energy savings and acceptable performance.

# Appendix A:

# EPA Pre-Rinse Spray Valves Research Study Scope

# EPA Pre-Rinse Spray Valves Research Study Scope

## Purpose of research on pre-rinse spray valves:

The Energy Policy Act of 2005 (EPAct 2005) restricts pre-rinse spray valve sales in the United States to those with flow rates of 1.6 gallons per minute (gpm) or lower, as tested by the American Society for Testing and Materials (ASTM) F2324-03 standard test method for pre-rinse spray valves. ASTM F2324-03 also includes a test protocol designed to assess a pre-rinse spray valve's ability to remove food waste from plates that is measured in —cleanability," or in the time in seconds per plate cleaned. EPAct 2005 does not specify a necessary performance level based on the cleanability portion of the test protocol.

In recent years, manufacturers have begun to meet demands for more efficient products and have introduced ultra-high-efficiency pre-rinse spray valve models to the market with rated flow rates of 1.0 gpm or less. These spray valves have demonstrated ASTM-tested cleanability times equal to or better than standard models. However, minimal research has been done, particularly with these ultra-high-efficiency spray valves, to evaluate actual field usage times, water and energy savings, and customer satisfaction.

The U.S. Environmental Protection Agency (EPA) would like to determine if high-efficiency and ultra-high-efficiency pre-rinse spray valves perform as well as or better than their conventional counterparts (those with flow rates at or around the EPAct 2005 requirement of 1.6 gpm) in the field, as performance is critical for EPA to ensure the long-term water and energy savings associated with these products. Particularly, EPA is interested in determining whether users spend more time removing food waste from dishes using high-efficiency and/or ultra-high-efficiency pre-rinse spray valves than conventional valves, and, if so, whether the usage time increases to the point that it negates water and energy savings and impacts user satisfaction.

## Questions to be answered through independent, third-party research:

To assist in the development of a performance specification for pre-rinse spray valves, EPA seeks data that answers the following questions:

1. How do water usage and time usage vary among pre-rinse spray valves currently on the market?
2. Do usage times in the field correlate to cleanability times achieved using the ASTM F2324-03 test method?
3. How do flow rate, actual field usage time, and ASTM-tested cleanability time correlate to user satisfaction?

EPA is seeking independent data to answer the above questions. Below is an outline of the ideal research study scope.

## Scope:

**Goal:**

- For at least three weeks each, install at least one model of applicable (see next bullet) pre-rinse spray valves from each flow rate category listed below in a minimum of

10 facilities, for a total of three spray valves per facility. The pre-rinse spray valves for each facility should be made by different manufacturers whenever possible.
  - Category 1: pre-rinse spray valves with a rated flow rate ≥ 1.25 to 1.6 gpm;
  - Category 2: pre-rinse spray valves with a rated flow rate ≥ 1.0 to <1.25 gpm; and
  - Category 3: pre-rinse spray valves with a rated flow rate < 1.0 gpm.
- Applicable pre-rinse spray valves must have posted ASTM F2324-03 test results from the Food Service Technology Center. A list of applicable pre-rinse spray valve models can be found at www.fishnick.com/equipment/sprayvalves.

**Facilities:**

- Target facilities that have an existing pre-rinse spray valve with a rated flow rate of ≤1.6 gpm.[15]
- Target facilities that use commercial pre-rinse spray valves for use with commercial dishwashing and ware washing equipment.[16]
- Target facilities that have a commercial dishwasher.[17]
- Target facilities that serve on china dishware, not plasticware.[18]
- Track facilities contacted to keep record of the number of facilities that did not qualify because they did not meet any of the above-mentioned criteria. Track facilities that decline to participate and document the reasoning.

**Equipment Needed for Study:**

- Graduated pail/container (one per person collecting data);
- Stop watch or watch with a second hand (one per person collecting data);
- Pressure gauge and adaptor (one set per person collecting data);
- Usage counters/flow totalizers or inline meter (one per facility for single water supply line; two per facility for separate hot and cold water supply lines);
- Pre-rinse spray valves (enough to have one new pre-rinse spray valve installed at each facility during each installation period; pre-rinse spray valves should not be interchanged among facilities as scaling or use may impact test results in later installation periods);
- Wrench (one per person collecting data);
- Teflon tape (one roll per person collecting data);
- Thermometer (one per person collecting data);
- Tape measure (one per person collecting data); and
- Digital camera (one per person collecting data).

[15] When recruiting participants for this field study, note that participating facilities should have EPAct-compliant PRSVs already installed in the facility. EPA is not interested in studying flow rate, usage time, and user satisfaction comparisons with PRSVs that can no longer be sold in the U.S. For accurate comparison of models currently available on the market, EPA would like to limit facility selection to only those facilities already using PRSVs flowing at 1.6 gpm or lower.
[16] EPA is interested in looking at PRSVs that meet the EPAct 2005 definition for commercial PRSVs. These PRSVs typically use hot water only and reduced flow rate should result in energy savings.
[17] PRSVs are intended to be used for pre-cleaning dishes prior to entering a commercial dishwasher, not for cleaning or sanitizing dishes. Targeted facilities should have a commercial dishwasher in place.
[18] Targeting facilities that use china will make data more comparable to the ASTM test method, which uses china dishes.

**Photo Documentation:**

- Take digital photographs and/or video clips during the installation periods to document field conditions, pre-rinse spray valve use, and dish cleaning operations, where such documentation will assist in data analysis.

**Baseline Measurements at Participating Facilities:**

- Identify the make and model of the existing pre-rinse spray valve that receives the most use and/or that is used for the purposes of pre-cleaning the dishes prior to the commercial dishwasher. Use this pre-rinse unit for the purpose of the study.
- The original valve should be monitored during the pre-installation period for at least three weeks, and the following measurements should be taken:
  - Using a stop watch or a watch with a second hand and graduated pail, measure and record the baseline flow rate of the existing pre-rinse spray valve at the beginning of the pre-installation period.
  - Using a pressure gauge, measure and record the static and flowing water pressure at least once during the pre-installation period. Water pressure should be measured in-line prior to the spray hose (at the inlet to the spray hose) and after the spray hose but before the pre-rinse spray valve.
  - Using the usage counter/flow totalizer or inline meter, measure and record the total gallons used and/or the total time spent using the existing pre-rinse spray valve during the pre-installation period.
  - Using a thermometer, measure and record the hot- and cold-water temperature from a separate faucet (not using the pre-rinse spray valve) at the facility as many times as is feasible during the pre-installation period. If multiple temperature measurements are taken, average the temperatures to calculate the representative water temperature for the pre-installation period.
  - Using a thermometer, measure and record the outlet water temperature (with the mixing valves adjusted as per normal operation) from the existing pre-rinse spray valve as many times as is feasible during the pre-installation period. If multiple temperature measurements are taken, average the temperatures to calculate the representative water temperature for the pre-installation period.
- Provide a description and photo documentation of the entire pre-rinse unit, including measurements of the inside hose diameter and hose length, description of hot water and cold water supply lines (combined, separate, etc.), and descriptions of any other important parameters.
- Document and photograph the make, model, and type of dishwasher(s) present in the facility (e.g., under counter, stationary single tank door, single tank conveyor, multiple tank conveyor, high or low temperature unit).
- At the end of the pre-installation period, spray valve operators should be interviewed briefly to assess user satisfaction, answering at least the following questions:
  - Are you satisfied with the current pre-rinse spray valve?
  - What do you like about the valve?
  - What do you dislike about the valve?
  - What type of food/residue is particularly hard to clean from plates?
  - What type of dishes do you wash daily (e.g. mostly plates, pots and pans, utensils)?
  - Do you typically clean dishes separately or in a rack? If different for different dishes, please explain.

  - How completely do you pre-rinse the dishes? Is your dishwasher effective in removing waste missed by the spray valve?
  - Ask operator to demonstrate dish cleaning method. Observe the spray pattern, distance spray valve is held from plate, angle at which spray valve is held, and hand motion while cleaning the dish. Collect photo or video documentation, if possible.
  - Note whether the spray valve has an "always on" clamp. If so, ask the spray valve operator how frequently they use the clamp.
- Facility managers should provide the following business information for the pre-installation testing period:
  - Typical hours of facility operation;
  - General type of food the facility serves for each mealtime;
  - Number of customers served and/or volume of dishes washed (per day, per week);
  - Any information about atypical business (i.e., special events);
  - If their water is heated by electricity, natural gas, or other means;
  - If their pre-rinse spray valves use hot water, cold water, or both;
  - If there is a mixing valve on their faucet that feeds their pre-rinse spray valve; and
  - How long the spray valves usually last and/or how frequently they are replaced.

**New Installation for Each Participating Facility:**

- The three pre-rinse spray valves (one from each flow rate category) should be installed for at least three weeks each (hereafter referred to as the installation period). The test should be a blind test—the user should not know the flow rate of the valve being installed. The order of installation should be done at random (i.e., flow rate should not ramp up or ramp down during the study; pre-rinse spray valve selection per week should be randomly generated). See example schedule matrix below.

| Flow Rate Category | Pre-Rinse Spray Valve |
|---|---|
| ≥ 1.25 to 1.6 gpm | Model A |
| ≥ 1.0 to <1.25 gpm | Model B |
| < 1.0 gpm | Model C |
| | |
| Week | Valve Installed |
| 1 – 3 | Existing Valve |
| 4 – 6 | Model B |
| 7 – 9 | Model C |
| 10 – 12 | Model A |

- All new pre-rinse spray valves should be installed on the existing pre-rinse units at each facility (the only variable will be the spray valve, not the entire spray unit; spray units may vary by location), and the following measurements should be taken:
  - Using a stop watch or a watch with a second hand and graduated pail, measure and record the flow rate of each pre-rinse spray valve at the beginning of each installation period.
  - Using a pressure gauge, measure and record the static and flowing water pressure at least once during each installation period. Water pressure should be measured in-

line prior to the spray hose (at the inlet to the spray hose) and after the spray hose but before the pre-rinse spray valve.
  - Using the usage counter/flow totalizer or inline water meter, measure and record the total gallons used and/or the total time spent using each pre-rinse spray valve during each installation period.
  - Using a thermometer, measure and record the hot- and cold-water temperatures from a separate faucet (not using the pre-rinse spray valve) at the facility as many times as is feasible during each installation period. If multiple temperature measurements are taken, average the temperatures to calculate the representative water temperature for that installation period.
  - Using a thermometer, measure and record the outlet water temperature (with the mixing valves adjusted as per normal operation) from each pre-rinse spray valve as many times as is feasible during each installation period. If multiple temperature measurements are taken, average the temperatures to calculate the representative water temperature for that installation period.
- At the end of each installation period, spray valve operators should be interviewed briefly to assess user satisfaction, answering at least the following questions:
  - Were you satisfied with the pre-rinse spray valve?
  - What did you like about the valve?
  - What did you dislike about the valve?
  - What type of food/residue was particularly hard to clean from plates using this pre-rinse spray valve?
  - Did you have to adjust the water temperature at all while using the valve? If so, did you adjust it to make the water hotter or colder? Why?
  - What type of dishes do you wash daily (e.g. mostly plates, pots and pans, utensils)?
  - Do you typically clean dishes separately or in a rack? If different for different dishes, please explain.
  - How completely do you pre-rinse the dishes? Is your dishwasher effective in removing waste missed by the spray valve?
  - Ask operator to demonstrate dish cleaning method. Observe the spray pattern, distance spray valve is held from plate, angle at which spray valve is held, and hand motion while cleaning the dish. Collect photo or video documentation, if possible.
  - Note whether the spray valve has an —always on" clamp. If so, ask the spray valve operator how frequently they used the clamp.
- Facility managers should provide the following business information for each installation period:
  - Number of customers served and/or volume of dishes washed (per day, per week)
  - Any information about atypical business (i.e., special events)
  - Any changes in the type of food served
- At the end the study, request the most recent water quality report from the facility's water utility.

## Data to provide to EPA:

- Background information regarding the facility and installation conditions at each site, including:

  - Inside hose diameter and hose length;
  - Hot water and cold water spigot descriptions (combined, separate, etc.);
  - Dishwasher make, model, and type, including a photograph;
  - Hot and cold water temperature (averages, if applicable) (from a separate faucet);
  - Pre-rinse spray valve outlet temperature (average, if applicable);
  - One photograph of the pre-rinse spray unit set up from each facility;
  - Existing pre-rinse spray valve make and model; and
  - Existing pre-rinse spray valve measured flow rate, static and flowing water pressure, and total baseline water and/or time usage recorded during the pre-installation period.
- Make, model, and measured flow rate of each pre-rinse spray valve being tested and static and flowing water pressure, outlet water temperature (average, if applicable), and total water and/or time usage recorded for each tested pre-rinse spray valve during each installation period.
- Hot and cold water temperature (averages, if applicable) (from a separate faucet) collected during each installation period.
- A description of the random pre-rinse spray valve installation order for each facility (schedule matrix would suffice).
- Responses to the survey of spray valve operators (one for the existing spray valve and one for each tested model) and responses to the survey questions from each facility manager (for baseline and each separate installation period).
- Additional photographs or videos, if applicable.
- The most recent water quality report from the facility's water utility.

# Appendix B:

# Weekly Site Visit Measurements Form

# Pre-Rinse Spray Valves Field Study
# Weekly Site Visit Measurements

**Facility/Site Name:** _____

**Week #:** _____

**Valve Being Monitored:** _____

**Date of Visit:** _____

**Visit Time:** _____

**Date Logger ID:** _____

**Water Meter ID:** _____

**Equipment Needed:**

- Graduated pail/container (to measure flow rate, assess any issues with collecting flow rate, and to measure water temperature);
- Stop watch or watch with a second hand (to measure flow rate);
- Pressure gauge and adaptor (to measure water pressure)
- Thermometer (to measure water temperature);
- Wrench (to remove and re-install pre-rinse spray valves);
- Teflon tape (to help re-install pre-rinse spray valves);
- Towel (to keep things dry and help with pre-rinse spray valve removal);
- WD-40 (in case pre-rinse spray valve is difficult to remove);
- Digital camera (to photograph the pre-rinse spray unit and dishwashing operations); and
- In-line water meter and data logger (to monitor water use) (already installed).

## 1.0 Review of Previous Visit

Water meter reading from beginning of week's collection: _____

Are there any noticeable differences from the previous site visit? Are there any changes that have since disqualified the facility from participating in the study?:

_____

_____

Do the water meter and data logger appear to be functioning correctly?

_____

_____

Does the site contact have any questions or concerns?

_____

_____

## 2.0 Water Meter Reading (when turning data logger off to download data) and Data Download

Turn data logger off.

Water meter reading when data logger is turned off to download data: _____

Date and exact time of reading: _____

Download data, export report, and clear the data for the next one-week period.

## 3.0 Data Logger Maximum Flow Rate (at Operating Temperature)

Without adjusting water temperature using the faucet spigots, hook the data logger up to the computer and the sensor. View the real-time data display in 10-second average intervals and depress the pre-rinse spray valve fully for one minute. Record the maximum flow rate that the data logger recognizes at the operating temperature (located at the top left of real-time screen).

Maximum flow rate from data logger at operating temperature: _____

## 4.0 Monitored Pre-Rinse Spray Valve Information

Manufacturer: _____

Model: _____

Rated flow rate (including pressure tested at), if applicable: _____

## 5.0 Operating Temperature, Flow Rate, and Pressure

Allow the pre-rinse spray valve to flow for 30 seconds to flush out water stored in the hose that may have adjusted to room temperature.

Without adjusting water temperature using the faucet spigots, collect the operating temperature.

**Operating Temperature**

| Trial | Measured Temperature of Normal Operation (°F) |
|---|---|
| 1 | |
| 2 | |
| 3 | |

Notes about operating temperature:

_____

_____

_____

Without adjusting water temperature using the faucet spigots, collect the operating flow rate.

**Operating Flow Rate**

| Trial | Measured Flow Rate in milliliters/second(s) | Measured Flow Rate in gallons/ minute (mL/seconds * (1 gallon/ 3,785.41178 mL) * (60 seconds/minute) = gallons/minute) |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |

Notes about operating flow rate:

_____

_____

_____

Still without adjusting water temperature using the faucet spigots, if possible, turn off the hot and cold water shut-off valves below the sink, and install the pressure adaptor and pressure gauge. Collect static and flowing water pressure by turning the shut-off valves under the sink back on (not adjusting the faucet spigots). If shut-off valves are not available, mark this section not applicable and note it.

**Operating Static and Flowing Water Pressure**

| Trial | Static Pressure (psi) | Flowing Pressure (psi) | Additional Water-using Equipment On During Trial |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |

Notes about water pressure:

_____

_____

_____

Turn the below-sink shut-off valves off to remove the pressure adaptor and pressure gauge. Turn the shut-off valves back on to allow water to flow for the cold and hot water temperature measurements.

### 6.0 Hot and Cold Water Temperature

Opening the cold water spigot completely (closing the hot water), then opening the hot water spigot completely (closing the cold water), collect hot and cold water temperature. Allow cold or hot water to flow through the hose for 30 seconds before taking measurements for temperature to adjust.

**Hot and Cold Water Temperature**

| Trial | Measured Temperature of Cold Water (°F) | Measured Temperature of Hot Water (°F) |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |

Notes about cold and hot water temperature:

_____

_____

_____

## 7.0 Maximum Flow Rate and Water Pressure

Opening the hot and cold water spigots completely, collect the maximum flow rate.

**Maximum Flow Rate**

| Trial | Measured Flow Rate in milliliters/second(s) | Measured Flow Rate in gallons/ minute (mL/seconds * (1 gallon/ 3,785.41178 mL) * (60 seconds/minute) = gallons/minute) |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |

Notes about maximum flow rate:

_____

_____

_____

Turn the hot and cold water spigots (or the below-sink shut-off valves) off completely to install the pressure adaptor and pressure gauge. Open the below-sink shut-off valves (if turned off) and the hot and cold water spigots completely, and collect static and flowing water pressure.

**Maximum Static and Flowing Water Pressure**

| Trial | Static Pressure (psi) | Flowing Pressure (psi) | Additional Water-using Equipment On During Trial |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |

Notes about maximum water pressure:

_____

_____

_____

### 8.0 Return Water Temperature to Operating

Return the water temperature to the facility's operating temperature (measured above) by adjusting the spigots how they were upon arriving and confirming with a temperature measurement (coming as close to the average operating temperature measured above as possible).

### 9.0 Conduct User Satisfaction Survey then Install New Pre-Rinse Spray Valve (if applicable)

If this is a pre-rinse spray valve change week, conduct the user satisfaction survey. Then, install the new pre-rinse spray valve.

### 10.0 Water Meter Reading (when turning data logger back on to record data)

Turn data logger on.

Water meter reading when data logger is turned back on to record data: _____

Date and exact time of reading: _____

### 11.0 Other Issues Noted

List any issues that may affect quality of data collected. This can include technical complications or issues obtaining survey results from staff.

_____

_____

_____

_____

_____

_____

_____

# Appendix C:

# User Satisfaction Survey

# Pre-Rinse Spray Valves Field Study
# User Satisfaction Survey

**Facility/Site Name:** _____

**Week #:** _____

**Valve Being Monitored:** _____

**Date of Visit:** _____

**Name of Operator:** _____

**Questions Asked During Every Survey**

1. On a scale from 1 to 3 (1 for unsatisfied, 2 somewhat satisfied, and 3 for completely satisfied), how satisfied are you with the dish sprayer? If unsatisfied, explain.

2. On a scale from 1 to 3 (1 for unsatisfied, 2 somewhat satisfied, and 3 for completely satisfied), how satisfied are you with the dish sprayer's pressure? If unsatisfied, was it too strong, too weak, produced excessive backsplash, produced misting, other?

3. On a scale from 1 to 3 (1 for unsatisfied, 2 somewhat satisfied, and 3 for completely satisfied), how satisfied were you with the dish sprayer's ability to clean the dishes? If unsatisfied, was it too slow, too fast, other?

4. On a scale from 1 to 3 (1 for satisfied, 2 for somewhat satisfied, 3 for unsatisfied), how satisfied were you with the dish sprayer's spray pattern? If unsatisfactory, was it too wide, too focused, non-uniform coverage, required modified use pattern, other?

5. Did you have to adjust the water temperature when using this pre-rinse spray valve? If so, did you make it hotter or colder? Why?

6. If you were making the purchasing decision, would you buy this dish sprayer?

7. What do you like about the dish sprayer?

8. What do you dislike about the dish sprayer?

9. What type of food/residue is particularly hard to clean from plates with this dish sprayer?

10. Do you ever use something to hold this dish sprayer in the on position so it is constantly spraying (rather than manually holding it on)? If so, what do you use to hold it on and how often do you do this?

11. Can you demonstrate your dish cleaning method? We would like to observe you cleaning the dishes as you normally would and collect a photo or video (not including your face, but showing how you are cleaning the dishes). Is this okay?

**Questions Asked Only During Baseline (first) Survey**

12. What type of dishes do you wash daily (e.g. mostly plates, pots and pans, utensils)?

13. Do you typically clean dishes separately or in a rack? If different for different dishes, please explain.

14. How completely do you rinse the dishes? Is your dishwasher effective in removing waste missed by the spray valve?

# Appendix D:

# Data, User Satisfaction Survey Responses, and Facility Operations Survey Responses

## Table D-1. Harvard University Mather House Data

| Harvard University Mather House | | | | |
|---|---|---|---|---|
| PRSV | K | A | F | N |
| PRSV | Existing | 1st New Valve | 2nd New Valve | 4th New Valve |
| Flow rate category (1 = high, 2 = mid, 3 = low) | 1 | 3 | 1 | 3 |
| Spray pattern | Fan | Fan | Shower | Fan |
| Week | Weeks 1–3 | Weeks 4–6 | Weeks 7–9 | Weeks 11–13 |
| Total days used (days) | 20.90 | 20.92 | 20.94 | 19.82 |
| Total customer count | 13,774 | 14,221 | 12,793 | 13,825 |
| **WATER USED** | | | | |
| Total water used (gallons) | 607.3 | 256.9 | 1077.4 | 314.6 |
| Water used per day (gallons per day) | 29.1 | 12.3 | 51.4 | 15.9 |
| **TIME USED** | | | | |
| Total time used (minutes) | 661.4 | 509.0 | 957.8 | 629.1 |
| Time used per day (minutes per day) | 31.6 | 24.3 | 45.7 | 31.7 |
| **DATA MEASURED WEEKLY** | | | | |
| Operating static water pressure (psi) | NC | NC | NC | 41 |
| Operating flowing water pressure (psi) | NC | NC | NC | 38 |
| Maximum static water pressure (psi) | 50 | 50 | NC | 44 |
| Maximum flowing water pressure (psi) | 41 | 46 | NC | 40 |
| Operating water temperature (°F) | 104.2 | 120.5 | 127.0 | 119.0 |
| Cold water temperature (°F) | 54.2 | 61.7 | 59.6 | 74.3 |
| Hot water temperature (°F) | 118.5 | 124.3 | 129.5 | 125.7 |
| Operating measured flow rate (gpm) | NC | NC | 1.13 | 0.51 |
| Maximum measured flow rate (gpm) | 0.97 | 0.56 | 1.27 | 0.58 |
| Cleanability | 17 | 21 | 21 | 21 |
| **USER SATISFACTION** | | | | |
| Overall user satisfaction (1 = unsatisfied, 2 = somewhat satisfied, 3 = completely satisfied) | 3 | 3 | 3 | 2 |

NC – Not collected.
Blue highlight designates the PRSV the user selected to keep.

**NOTES:**
Harvard Mather House is an undergraduate residence hall on the Harvard University campus. It serves all meals (breakfast, lunch, dinner, and sometimes snacks) and offers a very diverse cuisine.

Valve M was originally slated as the third valve. After the first week of testing (week 10), the spray head fell off and completely fell apart. After replacing Valve M with Valve N, a full three week's worth of data was collected (weeks 11-13).

Harvard Mather's garbage disposal system runs recirculated water through a trough where the PRSV user can dump food. Oftentimes, the PRSV user used the running flow to rinse the dishes rather than using the PRSV. The PRSV at this site was rarely used, so time usage and water usage may be low for a facility of this size.

## Table D-2. Harvard University Mather House User Satisfaction Survey Responses

| Harvard University Mather House | | | | |
|---|---|---|---|---|
| **User Information** | One user was interviewed at Harvard Mather House. He speaks Haitian Creole as his first language, French as his second language, and some English as his third. The user was interviewed verbally in French. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 4th New Valve |
| **PRSV** | K | A | F | N |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 2 |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| How satisfied are you with the spray valve? If unsatisfied, explain. | 3 | 3 | 3 | 1 (I am not satisfied with it. It is too slow.) |
| How satisfied are you with the spray valve's pressure? If unsatisfied, was it too strong, too weak, produced excessive backsplash, produced misting, other? | 3 | 3 | 3 | 2 (The pressure is too slow.) |
| How satisfied are you with the dish sprayer's ability to clean the dishes? If unsatisfied, was it too slow, too fast, other? | 3 | 2 | 3 | 2 (It would be okay if the pressure was better.) |
| How satisfied are you with the spray valve's spray pattern? If unsatisfactory, was it too wide, too focused, non-uniform coverage, required modified use pattern, other? | NA | NA | 3 | 3 |
| Do you have to adjust the water temperature when using this spray valve? If so, did you make it hotter or colder? Why? | NA | NA | I always use a little hot water and a little cold, but more hot. | I use a mix of hot and cold. |
| If you were making the purchasing decision, would you buy this spray valve? | NA | NA | Yes, it's good; perfect. | I don't know. |
| What do you like about this spray valve? | It has normal pressure. I don't always use the spray valve (only with food that sticks). | It's not too strong. The water doesn't come out too quickly. | It's not too fast but not too slow. | I like how it feels. |
| What do you dislike about this spray valve? | Nothing. | Nothing. | Nothing. It's perfect. | I do not like the pressure. |

## Table D-2. Harvard University Mather House User Satisfaction Survey Responses

| Harvard University Mather House | | | | |
|---|---|---|---|---|
| **User Information** | One user was interviewed at Harvard Mather House. He speaks Haitian Creole as his first language, French as his second language, and some English as his third. The user was interviewed verbally in French. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 4th New Valve |
| **PRSV** | K | A | F | N |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 2 |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| What type of food/residue is particularly hard to clean from plates with this spray valve? | Sticky rice, eggs, food left on a plate that has been sitting for awhile, sticky foods. | Food left overnight on plates is very hard to clean. Eggs in the microwave sticks to plates. | Trays/food from overnight, and eggs on a plate that went through the microwave. | Food that is left overnight. |
| Do you ever use something to hold the spray valve in the on position so it is constantly spraying (rather than manually holding it on)? If so, what do you use to hold it on and how often do you do this? | No, I just use it manually. | No, I don't need the clamp. Sometimes I use the adjacent hose/sprayer (on a reel with a higher flow rate) to fill up the sink and I would like a clamp for it. (NOTE: this wash down sprayer was not part of our study.) | No. | No. |
| What type of dishes do you wash daily (e.g., mostly plates, pots and pans, utensils)? | Plates, bowls, silverware, trays. | Plates, glasses, bowls, trays. | Plates, glasses, trays, some pots and pans. | NA |
| Do you typically clean dishes separately or in a rack? If different for different dishes, please explain. | Rack. | Rack. | Rack. | NA |
| How completely do you rinse the dishes? Is your dishwasher effective in removing waste missed by the spray valve? | Mostly clean. | The dishwasher is good. | NA | NA |
| Additional Comments | None. | None. | None. | None. |

## Table D-2. Harvard University Mather House User Satisfaction Survey Responses

| Harvard University Mather House | | | | |
|---|---|---|---|---|
| **User Information** | One user was interviewed at Harvard Mather House. He speaks Haitian Creole as his first language, French as his second language, and some English as his third. The user was interviewed verbally in French. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 4th New Valve |
| **PRSV** | K | A | F | N |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 2 |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| ERG Notes | The user seemed to be using the garbage disposal (which had a trough with recirculated running water to rinse food down the drain) to clean plates rather than the spray valve. He turned off the garbage disposal when it was not in use. Another user just pushed the plates through the dishwasher without spraying them down. | | | The user chose to keep this spray valve even though he gave it the worst satisfaction scores. The user seemed to be using the garbage disposal (which had a trough with recirculated running water to rinse food down the drain) to clean plates rather than the spray valve. He turned off the garbage disposal when it was not in use. Another user just pushed the plates through the dishwasher without spraying them down. |

**Table D-3. Harvard University Mather House Facility Operations Survey Responses**

| Questions | Responses |
|---|---|
| Typical hours of facility operation | 7:30am–10am, 12pm–2:15pm, 5pm–7:15pm |
| General type of food the facility serves for each mealtime | Various cuisine for breakfast, lunch, and dinner |
| Number of customers served and/or volume of dishes washed (per day, per week) | Provided in data tables above |
| Any information about atypical business (i.e., special events) | During the baseline monitoring period, the facility had a festive meal that may have resulted in an increase in customer count, and a long weekend occurred that may have resulted in a decrease in customer count. During the first new valve monitoring period, President's Day weekend may have caused decreased customer count and a parent's weekend may have caused increased customer counts. |
| Whether water is heated by electricity, natural gas, or other means | Steam |
| Whether pre-rinse spray valves use hot water, cold water, or both | Both |
| Whether a mixing valve on the faucet feeds the pre-rinse spray valve | No |
| How long the spray valves usually last and/or how frequently they are replaced | The spray valves last approximately two years |
| Any changes in the type of food served | None |

## Table D-4. Harvard University Currier House Data

| Harvard University Currier House | | | | |
|---|---|---|---|---|
| PRSV | K | L | D | J |
| PRSV | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| Flow rate category (1 = high, 2 = mid, 3 = low) | 1 | 2 | 1 | 3 |
| Spray pattern | Fan | Fan | Shower | Jet |
| Week | Weeks 1–3 | Weeks 4–6 | Weeks 7–9 | Weeks 10–12 |
| Total days used (days) | 20.90 | 20.92 | 20.93 | 21.48 |
| Total customer count | 14,954 | 14,172 | 13,173 | 15,379 |
| **WATER USED** | | | | |
| Total water used (gallons) | 250.6 | 230.0 | 247.7 | 153.7 |
| Water used per day (gallons per day) | 12.0 | 11.0 | 11.8 | 7.2 |
| **TIME USED** | | | | |
| Total time used (minutes) | 238.3 | 240.2 | 233.0 | 227.6 |
| Time used per day (minutes per day) | 11.4 | 11.5 | 11.1 | 10.6 |
| **DATA MEASURED WEEKLY** | | | | |
| Operating static water pressure (psi) | NC | NC | 54 | 51 |
| Operating flowing water pressure (psi) | NC | NC | 49 | 48 |
| Maximum static water pressure (psi) | 52 | 55 | 55 | 51 |
| Maximum flowing water pressure (psi) | 48 | 50 | 51 | 49 |
| Operating water temperature (°F) | 99.0 | 93.2 | 120.1 | 110.3 |
| Cold water temperature (°F) | 58.5 | 58.2 | 58.2 | 68.4 |
| Hot water temperature (°F) | 121.3 | 121.6 | 120.9 | 115.8 |
| Operating measured flow rate (gpm) | NC | NC | 1.06 | 0.55 |
| Maximum measured flow rate (gpm) | 1.08 | 1.00 | 1.08 | 0.66 |
| Cleanability | 17 | 23 | 21 | 21 |
| **USER SATISFACTION** | | | | |
| User 1's overall user satisfaction (1 = unsatisfied, 2 = somewhat satisfied, 3 = completely satisfied) | 3 | 3 | 1 | 1 |
| User 2's overall user satisfaction (1 = unsatisfied, 2 = somewhat satisfied, 3 = completely satisfied) | 3 | 3 | 2 | 2 |

NC – Not collected.
Blue highlight designates the PRSV the users selected to keep.

**NOTES**:
Harvard Currier House is an undergraduate residence hall on the Harvard University campus. It serves all meals (breakfast, lunch, dinner, and sometimes snacks) and offers a very diverse cuisine.

Harvard Currier has a garbage disposal system that runs recirculated water through a trough where the user can dump food. Oftentimes, users use the running flow to rinse the dishes rather than using the PRSV. In addition, this site had a second PRSV on a hose that kitchen staff draped over the garbage disposal and used to clean dishes sometimes. Both the PRSV on the unit before the dishwasher (the one metered and monitored for the study) and PRSV on the hose draped over the garbage disposal were

replaced with the new PRSVs monitored, so the users could accurately evaluate their satisfaction. The PRSV on the unit before the dishwasher at this site was rarely used, so time usage and water usage may be low for a facility of this size.

## Table D-5. Harvard University Currier House User Satisfaction Survey Responses

| Harvard University Currier House | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Harvard Currier House. User 1 worked the morning/day shift (~7–~3 p.m.) and User 2 worked the night shift (~3–~9 p.m.). Both users were native English speakers. The survey was administered to them verbally in English. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | K | | L | | D | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| How satisfied are you with the spray valve? If unsatisfied, explain. | 3 | 3 (I use the spray valve to clean the dishes and to clean up around the dish room.) | 3 (I am very satisfied.) | 3 | 1 (This spray valve tends to break easy. One is already leaking. Too much water comes out and it sprays right back at you.) | 1 (It sprays out too much water.) | 1 (It comes out different. Weaker. It seems like it is spitting out water. It is not a solid stream.) | 1 (It doesn't seem as good as the others.) |
| How satisfied are you with the spray valve's pressure? If unsatisfied, was it too strong, too weak, produced excessive backsplash, produced misting, other? | 3 | 3 | 3 | 3 | 1 (It produces backsplash. In the past when I've tried this valve it has been known to use more water.) | 3 (The pressure is good. I like Valve L better than Valve D.) | 1 (It is too weak.) | 2 (It is a little weak but it didn't produce excessive backsplash or misting.) |

## Table D-5. Harvard University Currier House User Satisfaction Survey Responses

| Harvard University Currier House | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Harvard Currier House. User 1 worked the morning/day shift (~7–~3 p.m.) and User 2 worked the night shift (~3–~9 p.m.). Both users were native English speakers. The survey was administered to them verbally in English. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | K | | L | | D | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| How satisfied are you with the dish sprayer's ability to clean the dishes? If unsatisfied, was it too slow, too fast, other? | 3 | 3 | 3 | 3 | 1 (The water comes out too fast.) | 3 (Very good.) | 1 (It is too slow. It felt like it took longer to clean the dishes.) | 3 |
| How satisfied are you with the spray valve's spray pattern? If unsatisfactory, was it too wide, too focused, non-uniform coverage, required modified use pattern, other? | NA | NA | NA | NA | 1 (It comes out weird. Each hole leads to water coming out in a criss-cross pattern.) | 1 (I like when it shoots out in a stream. This one is a fan.) | 1 (It is non-uniform. It spits and is not a solid stream.) | 2 (It's a little too straight. I want a little fan.) |

## Table D-5. Harvard University Currier House User Satisfaction Survey Responses

| Harvard University Currier House | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Harvard Currier House. User 1 worked the morning/day shift (~7–~3 p.m.) and User 2 worked the night shift (~3–~9 p.m.). Both users were native English speakers. The survey was administered to them verbally in English. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | K | | L | | D | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| Do you have to adjust the water temperature when using this spray valve? If so, did you make it hotter or colder? Why? | NA | NA | NA | NA | No. | No. | No. | No. I leave it the way it is. I never touch it from the way it was. Other users may adjust it, but not me. |
| If you were making the purchasing decision, would you buy this spray valve? | NA | NA | NA | NA | No. | Never. | No. | No. |

## Table D-5. Harvard University Currier House User Satisfaction Survey Responses

| Harvard University Currier House | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Harvard Currier House. User 1 worked the morning/day shift (~7–~3 p.m.) and User 2 worked the night shift (~3–~9 p.m.). Both users were native English speakers. The survey was administered to them verbally in English. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | K | | L | | D | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| What do you like about this spray valve? | The wide spray pattern. | It has a good spray. It is convenient. | I like the way the water comes out of the nozzle, the wide spray and the rubber dishguard bumper. | I think it works well, has good pressure, cleans the dishes well, doesn't splash, has a good spray pattern. The spray itself is excellent and the way it cleans is excellent. There was no backsplash. | Nothing. | The pressure is good. | The color. | The water pressure is okay. |

## Table D-5. Harvard University Currier House User Satisfaction Survey Responses

| Harvard University Currier House | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Harvard Currier House. User 1 worked the morning/day shift (~7–~3 p.m.) and User 2 worked the night shift (~3–~9 p.m.). Both users were native English speakers. The survey was administered to them verbally in English. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | K | | L | | D | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| What do you dislike about this spray valve? | Nothing. | Nothing. | I would like an always-on clamp. | Nothing. | The spray back. | When I move it around to clean the dishes, it sprays all over me. | I don't like the way the water comes out. It seems like it takes longer for it to come out. | I don't like the straight spray. I like more of a fan, but not one that causes backsplash. I want one that sprays downward but fans out a little. |

## Table D-5. Harvard University Currier House User Satisfaction Survey Responses

| Harvard University Currier House | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Harvard Currier House. User 1 worked the morning/day shift (~7–~3 p.m.) and User 2 worked the night shift (~3–~9 p.m.). Both users were native English speakers. The survey was administered to them verbally in English. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | K | | L | | D | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| What type of food/residue is particularly hard to clean from plates with this spray valve? | I let plates soak in hot water if they need to. Eggs, food left on a plate longer than 3 days, melted cheese, and chicken are hard to remove. | Cheese and chili. | Food that is two or three days old. Students leave plates upstairs in their room and bring it back later. | Eggs over easy and hardened food. | Lasagna. | None really. Some nights the food is more gooey but it all comes off. | Mac and cheese and mashed potatoes. | Stuff that is taken to the students' rooms and left to dry. Ketchup and peanut butter harden. I have to soak these dishes to loosen them. |

## Table D-5. Harvard University Currier House User Satisfaction Survey Responses

| Harvard University Currier House | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Harvard Currier House. User 1 worked the morning/day shift (~7–~3 p.m.) and User 2 worked the night shift (~3–~9 p.m.). Both users were native English speakers. The survey was administered to them verbally in English. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | K | | L | | D | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| Do you ever use something to hold the spray valve in the on position so it is constantly spraying (rather than manually holding it on)? If so, what do you use to hold it on and how often do you do this? | I use the always-on clamp. If I hold the spray valve on all the time it makes my hands sore. | No, I only use my hand. | I like to use the always-on clamp. | I only use my hand to manually work the spray valve. | Yes, every so often but not all the time. Everyday, but not all the time. | Once in a good while. I use the always-on clamp more on the spray valve on the hose (NOTE: This one was not metered). | Yes, every so often I use the always-on clamp. | Sometimes I use the always-on clamp to add hot water to the garbage disposal trough. |
| What type of dishes do you wash daily (e.g., mostly plates, pots and pans, utensils)? | Plates, utensils, cups, not many pots and pans, food containers. | NA | Everything except pots, sometimes wash certain types of pans. | NA | China dishes, utensils, glasses, mugs, trays; sometimes special types of pots and pans. | Plates, bowls, cups, glasses, dessert plates, trays, silver platters. | NA | NA |

## Table D-5. Harvard University Currier House User Satisfaction Survey Responses

| Harvard University Currier House | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Harvard Currier House. User 1 worked the morning/day shift (~7–~3 p.m.) and User 2 worked the night shift (~3–~9 p.m.). Both users were native English speakers. The survey was administered to them verbally in English. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | K | | L | | D | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| Do you typically clean dishes separately or in a rack? If different for different dishes, please explain. | I spray the dishes off separately and then put them in a rack to go through the dishwasher. | Separately. | Separately. I find it more effective to not use the rack. | Separately. | Rack (for dishwasher). | I don't use the spray valve on the unit a lot. I use the spray valve on the hose. I clean the dishes separately. | NA | NA |

## Table D-5. Harvard University Currier House User Satisfaction Survey Responses

| Harvard University Currier House | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Harvard Currier House. User 1 worked the morning/day shift (~7–~3 p.m.) and User 2 worked the night shift (~3–~9 p.m.). Both users were native English speakers. The survey was administered to them verbally in English. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | K | | L | | D | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| How completely do you rinse the dishes? Is your dishwasher effective in removing waste missed by the spray valve? | I remove big chunks of food but leave minor residue. Sometimes I completely clean the dishes, but I try not to so I can let the machine do what it is supposed to do. The dishwasher is effective. Sometimes utensils have to go through twice. Sometimes dishes have to go through twice if the dish room is really busy. | I clean the dishes until they are almost clean/clean. The dishwasher is used to sterilize the dishes only. | The dishwasher is effective because it is really hot (~200 degrees F). | I rinse the dishes completely so there is no food left on the plate. The dishes have to be clean before they go into the machine or it would break the dishwasher. | Yes. | I do not clean the dishes completely. The dishwasher gets everything. Once in a while I'll have to run a dish through the dishwasher twice. | NA | NA |

## Table D-5. Harvard University Currier House User Satisfaction Survey Responses

| Harvard University Currier House | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Harvard Currier House. User 1 worked the morning/day shift (~7–~3 p.m.) and User 2 worked the night shift (~3–~9 p.m.). Both users were native English speakers. The survey was administered to them verbally in English. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | K | | L | | D | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| Additional Comments | I use the spray valve on the hose more often than the one on the unit. I use the garbage disposal water to clear off dishes the most. | This spray valve has spray back/misting. | I like Valve L better than Valve K. The spray pattern for the Valve K is the same as that for Valve L, but Valve L has a rubber dishguard bumper which is good in case it is dropped. (NOTE: He chose to keep this spray valve.) | I use the spray valve to clean the sink. I rinse the dishes in the running water from the garbage disposal first and this rinses them adequately for the most part. (NOTE: He chose to keep this spray valve.) | I don't like the spray pattern. It is too powerful and it seems like it wastes water. | Valve D has too much backsplash and sprays on you. I don't like it. | I don't use the spray valve on the unit much except to clean the dish room. This spray valve is too weak. | I use the spray valve on the unit to clean up. |

## Table D-5. Harvard University Currier House User Satisfaction Survey Responses

| Harvard University Currier House | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Harvard Currier House. User 1 worked the morning/day shift (~7–~3 p.m.) and User 2 worked the night shift (~3–~9 p.m.). Both users were native English speakers. The survey was administered to them verbally in English. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | K | | L | | D | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| ERG Notes | This site has two spray valves: one on a unit before the dishwasher (which was equipped with a meter and a data logger) and another on a hose that hung over the garbage disposal dish trough (which was not metered or monitored). The users seemed to be using the garbage disposal (which had a trough with recirculated running water to rinse food down the drain) to clean plates rather than either spray valve. | | | | | | | |

## Table D-6. Harvard University Currier House Facility Operations Survey Responses

| Questions | Responses |
|---|---|
| Typical hours of facility operation | 7:30 a.m.–10 a.m., 12 p.m.–2:30 p.m., 5 p.m.–7:30 p.m. |
| General type of food the facility serves for each mealtime | Various cuisine for breakfast, lunch, and dinner |
| Number of customers served and/or volume of dishes washed (per day, per week) | Provided in data tables above |
| Any information about atypical business (i.e., special events) | None |
| Whether water is heated by electricity, natural gas, or other means | Steam |
| Whether PRSVs use hot water, cold water, or both | Both |
| Whether a mixing valve on the faucet feeds the pre-rinse spray valve | No |
| How long the spray valves usually last and/or how frequently they are replaced | Once per year |
| Any changes in the type of food served | None |

## Table D-7. Boston College McElroy Commons Data

| Boston College McElroy Commons | | | | |
|---|---|---|---|---|
| PRSV | Z1 | D | C | J |
| PRSV | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| Flow rate category (1 = high, 2 = mid, 3 = low) | N/A | 1 | 2 | 3 |
| Spray pattern | Shower | Shower | Jet | Jet |
| Week | Weeks 1–3 | Weeks 4–6 | Weeks 7–9 | Weeks 10–12 |
| Total days used (days) | 21.11 | 20.94 | 20.92 | 21.00 |
| Total customer count | 106,270 | 101,201 | 102,111 | 110,258 |
| **WATER USED** | | | | |
| Total water used (gallons) | 6537.8 | 3220.4 | 2388.5 | 1909.0 |
| Water used per day (gallons per day) | 309.7 | 153.8 | 114.2 | 90.9 |
| **TIME USED** | | | | |
| Total time used (minutes) | 1724.3 | 2090.3 | 1938.3 | 2350.4 |
| Time used per day (minutes per day) | 81.7 | 99.8 | 92.7 | 111.9 |
| **DATA MEASURED WEEKLY** | | | | |
| Operating static water pressure (psi) | NC | NC | 71 | 66 |
| Operating flowing water pressure (psi) | NC | NC | 67 | 64 |
| Maximum static water pressure (psi) | 69 | 72 | 71 | 66 |
| Maximum flowing water pressure (psi) | 39 | 64 | 68 | 64 |
| Operating water temperature (°F) | 117.6 | 117.7 | 116.2 | 116.0 |
| Cold water temperature (°F) | NC | NC | 56.8 | 60.5 |
| Hot water temperature (°F) | 117.6 | 117.7 | 117.7 | 116.0 |
| Operating measured flow rate (gpm) | NC | NC | 1.25 | 0.81 |
| Maximum measured flow rate (gpm) | 3.66 | 1.53 | 1.27 | 0.82 |
| Cleanability | N/A | 21 | 22 | 21 |
| **USER SATISFACTION** | | | | |
| User 1's overall user satisfaction (1 = unsatisfied, 2 = somewhat satisfied, 3 = completely satisfied) | 3 | 2 | 2 | 1 |
| User 2's overall user satisfaction (1 = unsatisfied, 2 = somewhat satisfied, 3 = completely satisfied) | 1 | 3 | 2 | 1 |

NC – Not collected.
Blue highlight designates the PRSV the users selected to keep.

**NOTES**:
Boston College McElroy Commons is a large dining facility on Boston College's main campus. It serves breakfast, lunch, dinner, and late night food, has thousands of customers a day, and offers a very diverse cuisine.

This site had two PRSVs that were used side-by-side for the same purpose. It was a duplicate set up. ERG chose to monitor one of the two PRSVs with a data logger. Both PRSVs were replaced with the new PRSVs monitored, so the users could accurately evaluate their satisfaction.

When selecting the PRSV to keep, several users discussed the question. They decided that they liked both Valve D and Valve C and decided to keep one on each of their two units.

## Table D-8. Boston College McElroy Commons User Satisfaction Survey Responses

| Boston College McElroy Commons | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at BC McElroy. Both worked the night shift (~3–9 p.m.). Both users were native English speakers. The survey was administered verbally and the users provided responses verbally. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z1 | | D | | C | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 1 | 2 | 3 | 2 | 2 | 1 | 1 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| How satisfied are you with the spray valve? If unsatisfied, explain. | 3 | 1 (I would like the spray area to be more precise. This one sprays out too much.) | 2 | 3 (This one was similar to the last spray valve and they were both good.) | 2 | 1 | 1 (There is no pressure. This has the best design. The spray angle and pattern are good.) | 1 (It has no power or pressure.) |
| How satisfied are you with the spray valve's pressure? If unsatisfied, was it too strong, too weak, produced excessive backsplash, produced misting, other? | 2 (Streams are skinnier and misty, not as much water.) | 1 | 3 | 3 | 2 (It seems there may be too much pressure. It misted everywhere. I can get soaked.) | 3 (It's good, but I get soaked.) | 1 (Too weak.) | 1 (I have to get right on the plate or scrub to get the food off. The pressure is too weak.) |

## Table D-8. Boston College McElroy Commons User Satisfaction Survey Responses

| Boston College McElroy Commons | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at BC McElroy. Both worked the night shift (~3–9 p.m.). Both users were native English speakers. The survey was administered verbally and the users provided responses verbally. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z1 | | D | | C | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 1 | 2 | 3 | 2 | 2 | 1 | 1 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| How satisfied are you with the dish sprayer's ability to clean the dishes? If unsatisfied, was it too slow, too fast, other? | 3 | 2 | 2 | 3 | 3 | 3 | 1 (Too slow, it took longer to clean the plates.) | 1 (It took too long to clean the plates. I like the design, the always-on clamp, because it gives my wrist a rest.) |
| How satisfied are you with the spray valve's spray pattern? If unsatisfactory, was it too wide, too focused, non-uniform coverage, required modified use pattern, other? | NA | NA | NA | NA | 1 (Too narrow.) | 1 (There is only one spout.) | 3 | 3 (I am able to direct the spray right where I want it to go because it is a straight spray pattern. I don't like the fan spray.) |

## Table D-8. Boston College McElroy Commons User Satisfaction Survey Responses

| Boston College McElroy Commons | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at BC McElroy. Both worked the night shift (~3–9 p.m.). Both users were native English speakers. The survey was administered verbally and the users provided responses verbally. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z1 | | D | | C | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 1 | 2 | 3 | 2 | 2 | 1 | 1 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| Do you have to adjust the water temperature when using this spray valve? If so, did you make it hotter or colder? Why? | NA | NA | NA | NA | No. | No. | No. I always use all hot water. | No. |
| If you were making the purchasing decision, would you buy this spray valve? | NA | NA | NA | NA | No. | No. | No. | Yes, because I liked the design of the spray valve. |

## Table D-8. Boston College McElroy Commons User Satisfaction Survey Responses

| Boston College McElroy Commons | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at BC McElroy. Both worked the night shift (~3–9 p.m.). Both users were native English speakers. The survey was administered verbally and the users provided responses verbally. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z1 | | D | | C | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 1 | 2 | 3 | 2 | 2 | 1 | 1 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| What do you like about this spray valve? | It gives off a lot of water and has good pressure. | The spray spreads over a large area. | The pressure is good. | I liked that the spray pattern seemed to converge on one spot. I do not like the fan spray models. I like to be able to direct the spray at one spot. I am very satisfied with the spray pattern of this spray valve. | The pressure was too much but that would be the only good thing. | The design is nice. | I like the spray pattern, the handle with the always-on clamp, and how it is small. I like the design. | I like the design, the always-on clamp, and the spray pattern. |

## Table D-8. Boston College McElroy Commons User Satisfaction Survey Responses

| Boston College McElroy Commons | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at BC McElroy. Both worked the night shift (~3–9 p.m.). Both users were native English speakers. The survey was administered verbally and the users provided responses verbally. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z1 | | D | | C | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 1 | 2 | 3 | 2 | 2 | 1 | 1 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| What do you dislike about this spray valve? | Nothing. | It's hard to clean one small area, for example, the corner of a pan. | I felt like I had to move the spray valve closer to the plate to get the spray streams to converge to a point to be able to clean the dishes. If I held it too far away the sprays crossed. I felt I had to hold the spray valve at exactly the right angle/height. The amount of water that sprayed out was too little and caused misting and backsplash. I felt that it took longer to clean larger items (like bins) than normal. | Nothing. | It was hard to depress the spray valve. I felt like I got a workout. | The handle is hard to depress and ~~-in~~stalled backwards. ” | I do not like the pressure—that is the main thing. It felt like it took longer to clean the plates. | There is no pressure or power. |

## Table D-8. Boston College McElroy Commons User Satisfaction Survey Responses

| Boston College McElroy Commons | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at BC McElroy. Both worked the night shift (~3–9 p.m.). Both users were native English speakers. The survey was administered verbally and the users provided responses verbally. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z1 | | D | | C | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 1 | 2 | 3 | 2 | 2 | 1 | 1 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| What type of food/residue is particularly hard to clean from plates with this spray valve? | Sticky rice, mac and cheese. | Dried oatmeal or cereal. I let the dish soak if there is residue on it. | NA | Nothing was harder to clean than normal. Cereal or oatmeal is hard to remove, as I said before. | Dry cereal and dry sauces are hard to remove. The same foods were difficult to remove with this spray valve than the others. | Cereal gets stuck, or sauce, depending on how long it's been sitting. | Same as usual. It took longer to clean easy things. | With this sprayer, everything. |
| Do you ever use something to hold the spray valve in the on position so it is constantly spraying (rather than manually holding it on)? If so, what do you use to hold it on and how often do you do this? | No, just manually. | No, just manually. | No, just hand. | No, just hand. | No. | I do not use clamps. | I used the always-on clamp once in awhile while using this valve. | Yes, I always use the always-on clamp when I am using the spray valve. |

## Table D-8. Boston College McElroy Commons User Satisfaction Survey Responses

| Boston College McElroy Commons | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at BC McElroy. Both worked the night shift (~3–9 p.m.). Both users were native English speakers. The survey was administered verbally and the users provided responses verbally. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z1 | | D | | C | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 1 | 2 | 3 | 2 | 2 | 1 | 1 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| What type of dishes do you wash daily (e.g., mostly plates, pots and pans, utensils)? | Everything. | Everything. | NA | NA | NA | NA | NA | NA |
| Do you typically clean dishes separately or in a rack? If different for different dishes, please explain. | Separately. | Separately. | NA | Separately. | NA | NA | NA | NA |

## Table D-8. Boston College McElroy Commons User Satisfaction Survey Responses

| Boston College McElroy Commons | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at BC McElroy. Both worked the night shift (~3–9 p.m.). Both users were native English speakers. The survey was administered verbally and the users provided responses verbally. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z1 | | D | | C | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 1 | 2 | 3 | 2 | 2 | 1 | 1 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| How completely do you rinse the dishes? Is your dishwasher effective in removing waste missed by the spray valve? | Pretty clean. The dishes are clean not sanitized. The dishwasher works well. | All of the food is cleared off before the plate goes to the dishwasher. I use my hand to run over the plate or dish to make sure it's smooth before I send it to the dishwasher. | Same as before. | Very completely. I rub my hand over the plate and clean it if I feel something left on the plate. The dishwasher is good unless it's stuck or broken and someone didn't fix it. | NA | NA | NA | NA |
| Additional Comments | None. | None. | None. | I wear gloves because the water is hot. | None. | None. | If I had to pick a spray valve to keep, I would pick Valve D. | If I had to pick a spray valve to keep, I would pick this one. |

## Table D-8. Boston College McElroy Commons User Satisfaction Survey Responses

| Boston College McElroy Commons | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at BC McElroy. Both worked the night shift (~3–9 p.m.). Both users were native English speakers. The survey was administered verbally and the users provided responses verbally. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z1 | | D | | C | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 1 | 2 | 3 | 2 | 2 | 1 | 1 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| ERG Notes | This site has two spray valves set up side-by-side. A data logger was only installed on one unit, though both were metered. At the end of week 2, one of the baseline spray valves was dropped during the pressure measurements and the handle broke. It was replaced with the next spray valve to be tested (Valve D).This premature change out may have skewed user satisfaction responses. | | Several users stood around and discussed which spray valve to keep. They decided to keep Valve D on one unit and Valve C for the other. | | Several users stood around and discussed which spray valve to keep. They said that this spray valve has too much pressure, caused misting, and got them wet. However, they decided to keep Valve C on one unit and Valve D for the other. | | Several users stood around and discussed the spray valves to pick which one they wanted to keep. They said that this spray valve had too little pressure. | |

## Table D-9. Boston College McElroy Commons Facility Operations Survey Responses

| Questions | Responses |
|---|---|
| Typical hours of facility operation | Monday–Thursday: 7:30 a.m.–12 a.m., Friday–Saturday: 7:30 a.m.–2 a.m., Sunday: 8 a.m.–12 a.m. |
| General type of food the facility serves for each mealtime | Various cuisine for breakfast, lunch, dinner, and late night snacks |
| Number of customers served and/or volume of dishes washed (per day, per week) | Provided in data tables above |
| Any information about atypical business (i.e., special events) | None |
| Whether water is heated by electricity, natural gas, or other means | Steam |
| Whether PRSVs use hot water, cold water, or both | Both |
| Whether a mixing valve on the faucet feeds the PRSV | No |
| How long the spray valves usually last and/or how frequently they are replaced | 6–8 months |
| Any changes in the type of food served | None |

## Table D-10. Boston College Stuart Hall Data

| Boston College Stuart Hall | | | | |
|---|---|---|---|---|
| PRSV | Z2 | I | K | M |
| PRSV | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| Flow rate category (1 = high, 2 = mid, 3 = low) | N/A | 2 | 1 | 2 |
| Spray pattern | Shower | Fan | Fan | Fan |
| Week | Weeks 1–3 | Weeks 4–6 | Weeks 7–9 | Weeks 10–11, 13 |
| Total days used (days) | 20.95 | 20.92 | 20.87 | 20.69 |
| Total customer count | 45,862 | 45,593 | 46,832 | 45,694 |
| **WATER USED** | | | | |
| Total water used (gallons) | 1051.2 | 510.6 | 820.2 | 401.1 |
| Water used per day (gallons per day) | 50.2 | 24.4 | 39.3 | 19.4 |
| **TIME USED** | | | | |
| Total time used (minutes) | 279.7 | 444.5 | 680.0 | 395.7 |
| Time used per day (minutes per day) | 13.4 | 21.2 | 32.6 | 19.1 |
| **DATA MEASURED WEEKLY** | | | | |
| Operating static water pressure (psi) | NC | NC | 78 | 69 |
| Operating flowing water pressure (psi) | NC | NC | 57 | 51 |
| Maximum static water pressure (psi) | 75 | 77 | 78 | 71 |
| Maximum flowing water pressure (psi) | 39 | 71 | 72 | 64 |
| Operating water temperature (°F) | 92.9 | 112.3 | 118.3 | 105.1 |
| Cold water temperature (°F) | 58.9 | 59.3 | 70.3 | 68.5 |
| Hot water temperature (°F) | 124.7 | 119.5 | 123.8 | 119.8 |
| Operating measured flow rate (gpm) | NC | NC | 1.18 | 1.10 |
| Maximum measured flow rate (gpm) | 4.05 | 1.29 | 1.35 | 1.20 |
| Cleanability | N/A | 22 | 17 | 20 |
| **USER SATISFACTION** | | | | |
| Overall user satisfaction (1 = unsatisfied, 2 = somewhat satisfied, 3 = completely satisfied) | 2 | 3 | 3 | 3 |

NC – Not collected.
Blue highlight designates the PRSV the user selected to keep.

**NOTES:**
Boston College Stuart Hall is a residential dining hall on Boston College's law school campus. The dining hall is open for breakfast, lunch, dinner, and late night snacks. It offers a very diverse cuisine.

After week 12, the data logger malfunctioned and would not allow the weekly data download. A new data logger was installed to capture a thirteenth week of data to ensure that a full three-week period was captured.

## Table D-11. Boston College Stuart Hall User Satisfaction Survey Responses

| Boston College Stuart Hall | | | | |
|---|---|---|---|---|
| **User Information** | One user was interviewed at BC Stuart Hall. She worked the morning shift (~7 a.m.–3 p.m.) Monday through Friday. Her first language is Spanish, but she speaks some English. To take the user satisfaction surveys, she read the survey question translated into Spanish and responded verbally in English. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | Z2 | I | K | M |
| **Overall Satisfaction Score Based on All Responses** | 2 | 3 | 3 | 3 |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| How satisfied are you with the spray valve? If unsatisfied, explain. | 1 | 3 | 3 | 3 |
| How satisfied are you with the spray valve's pressure? If unsatisfied, was it too strong, too weak, produced excessive backsplash, produced misting, other? | 3 | 3 | 3 | 3 |
| How satisfied are you with the dish sprayer's ability to clean the dishes? If unsatisfied, was it too slow, too fast, other? | 2 | 3 | 3 | 3 |
| How satisfied are you with the spray valve's spray pattern? If unsatisfactory, was it too wide, too focused, non-uniform coverage, required modified use pattern, other? | NA | NA | 3 | 3 |
| Do you have to adjust the water temperature when using this spray valve? If so, did you make it hotter or colder? Why? | NA | NA | No, kept it the same. | No. |
| If you were making the purchasing decision, would you buy this spray valve? | NA | NA | Yes. | Yes. |

## Table D-11. Boston College Stuart Hall User Satisfaction Survey Responses

| Boston College Stuart Hall | | | | |
|---|---|---|---|---|
| **User Information** | One user was interviewed at BC Stuart Hall. She worked the morning shift (~7 a.m.–3 p.m.) Monday through Friday. Her first language is Spanish, but she speaks some English. To take the user satisfaction surveys, she read the survey question translated into Spanish and responded verbally in English. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | Z2 | I | K | M |
| **Overall Satisfaction Score Based on All Responses** | 2 | 3 | 3 | 3 |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| What do you like about this spray valve? | It is strong. I like it. It is good to clean dishes. | It is okay. It's good. I like it. | The spray is good. There is no problem. | Everything is okay. |
| What do you dislike about this spray valve? | It splashes on me. It is too high. | Nothing. There is no problem with it. | No problem. | Nothing. |
| What type of food/residue is particularly hard to clean from plates with this spray valve? | Eggs because they are sticky. | Eggs because they are sticky. | Eggs because they are sticky. | Eggs. |
| Do you ever use something to hold the spray valve in the on position so it is constantly spraying (rather than manually holding it on)? If so, what do you use to hold it on and how often do you do this? | No, only use hand to manually operate the spray valve. | No, only use hand to manually operate the spray valve. | No, only use hand to manually operate the spray valve. | No, only use hand to manually operate the spray valve. |
| What type of dishes do you wash daily (e.g., mostly plates, pots and pans, utensils)? | Everything. | NA | NA | NA |
| Do you typically clean dishes separately or in a rack? If different for different dishes, please explain. | Hold the plates in a stack together and flip through them as the water is spraying. Do not use a rack. | NA | NA | NA |

## Table D-11. Boston College Stuart Hall User Satisfaction Survey Responses

| Boston College Stuart Hall | | | | |
|---|---|---|---|---|
| **User Information** | One user was interviewed at BC Stuart Hall. She worked the morning shift (~7 a.m.–3 p.m.) Monday through Friday. Her first language is Spanish, but she speaks some English. To take the user satisfaction surveys, she read the survey question translated into Spanish and responded verbally in English. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | Z2 | I | K | M |
| **Overall Satisfaction Score Based on All Responses** | 2 | 3 | 3 | 3 |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| How completely do you rinse the dishes? Is your dishwasher effective in removing waste missed by the spray valve? | The dishwasher gets the plates very clean. Sometimes I have to scrape food off with a foil rag. | If the food is sticky, I use a brillo pad. Sometimes I have to wash dishes two times in the dishwasher. | NA | NA |
| Additional Comments | None. | This one was better than the last one, though it is too strong and has too much backsplash. | None. | The straight jet spray is too strong. I like the dishguard bumper because it blocks the overspray. I like this spray valve best because it is easy to use and not heavy. (NOTE: She chose to keep this spray valve.) |

## Table D-11. Boston College Stuart Hall User Satisfaction Survey Responses

| Boston College Stuart Hall | | | | |
|---|---|---|---|---|
| **User Information** | One user was interviewed at BC Stuart Hall. She worked the morning shift (~7 a.m.–3 p.m.) Monday through Friday. Her first language is Spanish, but she speaks some English. To take the user satisfaction surveys, she read the survey question translated into Spanish and responded verbally in English. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | Z2 | I | K | M |
| **Overall Satisfaction Score Based on All Responses** | 2 | 3 | 3 | 3 |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| ERG Notes | When the meter was installed, it raised the height of the spray hose. The user was short and it was difficult for her to reach the hose at its new height. The hose was replaced with a longer hose sometime between week 3 and 5 so it would hang at a more optimal height. This may have affected her satisfaction with this valve. | None. | None. | None. |

## Table D-12. Boston College Stuart Hall Facility Operations Survey Responses

| Questions | Responses |
|---|---|
| Typical hours of facility operation | Monday–Friday: 7:15 a.m.–12 a.m., Saturday–Sunday: 9 a.m.–12 a.m. |
| General type of food the facility serves for each mealtime | Various cuisine for breakfast, lunch, dinner, and late night snacks |
| Number of customers served and/or volume of dishes washed (per day, per week) | Provided in data tables above |
| Any information about atypical business (i.e., special events) | During the baseline monitoring period, the customer throughput was slightly lower due to two law school ski trips. Customer throughput may have been slightly lower during the 3rd new valve monitoring period due to the school's exam schedule. |
| Whether water is heated by electricity, natural gas, or other means | Oil |
| Whether PRSVs use hot water, cold water, or both | Both |
| Whether a mixing valve on the faucet feeds the PRSV | No |
| How long the spray valves usually last and/or how frequently they are replaced | Not sure |
| Any changes in the type of food served | None |

## Table D-13. Buckingham Browne & Nichols School Data

| Buckingham Brown & Nichols School | | | | |
|---|---|---|---|---|
| PRSV | Z5 | B | E | C |
| PRSV | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| Flow rate category (1 = high, 2 = mid, 3 = low) | N/A | 2 | 3 | 2 |
| Spray pattern | Shower | Fan | Fan | Jet |
| Week | Weeks 1–2 | Weeks 3–4 | Weeks 5–6 | Weeks 7–8 |
| Total days used (days) | 11.75 | 11.94 | 11.96 | 11.93 |
| Total customer count | N/A | N/A | N/A | N/A |
| **WATER USED** | | | | |
| Total water used (gallons) | 2409.4 | 1257.9 | 1432.7 | 1165.8 |
| Water used per day (gallons per day) | 205.1 | 105.3 | 119.8 | 97.7 |
| **TIME USED** | | | | |
| Total time used (minutes) | 735.0 | 813.7 | 927.2 | 767.0 |
| Time used per day (minutes per day) | 62.6 | 68.1 | 77.6 | 64.3 |
| **DATA MEASURED WEEKLY** | | | | |
| Operating static water pressure (psi) | 72 | 67 | 68 | 67 |
| Operating flowing water pressure (psi) | 25 | 51 | 52 | 55 |
| Maximum static water pressure (psi) | 71 | 71 | 68 | 65 |
| Maximum flowing water pressure (psi) | 28 | 55 | 50 | 55 |
| Operating water temperature (°F) | 128.9 | 136.1 | 109.8 | 116.4 |
| Cold water temperature (°F) | 68.1 | 69.3 | 69.0 | 77.0 |
| Hot water temperature (°F) | 141.9 | 134.4 | 138.7 | 132.4 |
| Operating measured flow rate (gpm) | 3.21 | 1.57 | 1.54 | 1.29 |
| Maximum measured flow rate (gpm) | 3.48 | 1.63 | 1.62 | 1.30 |
| Cleanability | N/A | 24 | 25 | 22 |
| **USER SATISFACTION** | | | | |
| Overall user satisfaction (1 = unsatisfied, 2 = somewhat satisfied, 3 = completely satisfied) | 2 | 1 | 1 | 3 |

NC – Not collected.
Blue highlight designates the PRSV the user selected to keep.

**NOTES:**
BB&N is a private day school that serves breakfast, lunch, and snacks to students throughout the day. Throughput is consistent. The facility does not count customers because meals are included in students' tuition, so they are not charged for their meals.

Each two week period captures 12 school days. Weekends and holidays are excluded from this data set. When installed, Valve C was spraying water out of the ring around the spray nozzle (between the spray faceplate and the dishguard bumper). During the second week, the leaking Valve C model was replaced with the Valve C model that was used at Boston College McElroy Commons. It worked with no leaks.

**Table D-14. Buckingham Browne & Nichols School User Satisfaction Survey Results – Pre-Rinse Spray Valves Tested During Study**

| Buckingham Browne & Nichols School | | | | |
|---|---|---|---|---|
| **User Information** | One user was interviewed at Buckingham Browne & Nichols School, the sole dish washer and user of the PRSV. He works from 7 a.m.–2:30 p.m. His primary language is English. The survey was administered to him verbally in English. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | Z5 | B | E | C |
| **Overall Satisfaction Score Based on All Responses** | 2 | 1 | 1 | 3 |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| How satisfied are you with the spray valve? If unsatisfied, explain. | 1 (Terrible. Not enough pressure.) | 1 | 0 (Terrible. Worse pressure than the last one. Pressure is key to my job.) | 3 |
| How satisfied are you with the spray valve's pressure? If unsatisfied, was it too strong, too weak, produced excessive backsplash, produced misting, other? | 1 | 1 (It's very weak. I want a jet spray. This one is more of a showerhead. I want a direct, powerful spray. I have to work at cleaning the dishes.) | 0 (Too weak, extremely weak.) | 3 |
| How satisfied are you with the dish sprayer's ability to clean the dishes? If unsatisfied, was it too slow, too fast, other? | 1.5 (Not great. Pressure isn't great.) | 1 (Too slow.) | 0 (Too slow. Dishes are dirty when they come out of the dishwasher and I have to re-rinse a lot with this spray valve. I feel like I am using more water because it takes me longer. I am not able to do my job.) | 3 |

**Table D-14. Buckingham Browne & Nichols School User Satisfaction Survey Results – Pre-Rinse Spray Valves Tested During Study**

| Buckingham Browne & Nichols School | | | | |
|---|---|---|---|---|
| **User Information** | One user was interviewed at Buckingham Browne & Nichols School, the sole dish washer and user of the PRSV. He works from 7 a.m.–2:30 p.m. His primary language is English. The survey was administered to him verbally in English. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | Z5 | B | E | C |
| **Overall Satisfaction Score Based on All Responses** | 2 | 1 | 1 | 3 |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| How satisfied are you with the spray valve's spray pattern? If unsatisfactory, was it too wide, too focused, non-uniform coverage, required modified use pattern, other? | 2 (Too wide.) | 1 (If there was more pressure, the spray pattern would be fine. It is a bit too wide. It should be a jet stream. It is hard to spray into the dishwasher to clean it off.) | 1.5 (The spray pattern doesn't matter to me if there is pressure. A direct spray would be better, but spray pattern is not that important. It's hard to get stuff that is stuck on and hard to clean far places.) | 3 |
| Do you have to adjust the water temperature when using this spray valve? If so, did you make it hotter or colder? Why? | I try not to, but it can get too hot and I can get burned. | No, I keep it hot anyway because it cleans easier and it's more sanitary. | No, I'm not sure. Sometimes I mess with it. | No. |
| If you were making the purchasing decision, would you buy this spray valve? | No, absolutely not. | No. | No. | Yes. |
| What do you like about this spray valve? | No. | Nothing. | Nothing. The spray pattern is fine but the ideal is a straight spray like a showerhead with the massage setting. | Everything—it's the best by far. |

**Table D-14. Buckingham Browne & Nichols School User Satisfaction Survey Results – Pre-Rinse Spray Valves Tested During Study**

| Buckingham Browne & Nichols School | | | | |
|---|---|---|---|---|
| **User Information** | One user was interviewed at Buckingham Browne & Nichols School, the sole dish washer and user of the PRSV. He works from 7 a.m.–2:30 p.m. His primary language is English. The survey was administered to him verbally in English. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | Z5 | B | E | C |
| **Overall Satisfaction Score Based on All Responses** | 2 | 1 | 1 | 3 |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| What do you dislike about this spray valve? | NA | The pressure, the spray pattern because it's too wide (but it would be better if it had better pressure), the splash back when filling a bucket. I feel I can't do my job as well. | I don't like the pressure and the ability to clean. I don't like everything. | It's too heavy and hard to squeeze. |
| What type of food/residue is particularly hard to clean from plates with this spray valve? | Baked on stuff, mac and cheese, baked ziti, have to scrub and scrub. | Mac and cheese, baked on something, I have to scrub plates that are one or two days old. | Everything. | Nothing. |
| Do you ever use something to hold the spray valve in the on position so it is constantly spraying (rather than manually holding it on)? If so, what do you use to hold it on and how often do you do this? | No. | No, I don't use the always-on clamp. | Never. It's not smart and it's a waste of water. | Once in awhile I use it to fill up a bucket. |
| What type of dishes do you wash daily (e.g. mostly plates, pots and pans, utensils)? | Pots, pans, dishes, utensils bowls, glasses. | NA | NA | NA |

**Table D-14. Buckingham Browne & Nichols School User Satisfaction Survey Results – Pre-Rinse Spray Valves Tested During Study**

| Buckingham Browne & Nichols School | | | | |
|---|---|---|---|---|
| **User Information** | One user was interviewed at Buckingham Browne & Nichols School, the sole dish washer and user of the PRSV. He works from 7 a.m.–2:30 p.m. His primary language is English. The survey was administered to him verbally in English. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | Z5 | B | E | C |
| **Overall Satisfaction Score Based on All Responses** | 2 | 1 | 1 | 3 |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| Do you typically clean dishes separately or in a rack? If difference for different dishes, please explain. | Put in rack, spray down and put through dishwasher. | NA | NA | NA |
| How completely do you rinse the dishes? Is your dishwasher effective in removing waste missed by the spray valve? | Yes, sometimes you have to put them back through the dishwasher. The dishwasher is very hot. I don't have time to completely rinse the plates. | NA | NA | NA |

**Table D-14. Buckingham Browne & Nichols School User Satisfaction Survey Results – Pre-Rinse Spray Valves Tested During Study**

| Buckingham Browne & Nichols School | | | | |
|---|---|---|---|---|
| **User Information** | One user was interviewed at Buckingham Browne & Nichols School, the sole dish washer and user of the PRSV. He works from 7 a.m.–2:30 p.m. His primary language is English. The survey was administered to him verbally in English. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | Z5 | B | E | C |
| **Overall Satisfaction Score Based on All Responses** | 2 | 1 | 1 | 3 |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| Additional Comments | This spray valve is old and clogged. | I feel it takes me longer to clean the dishes with this spray valve. I don't care about or mind overspray because I will get wet regardless. I want a narrow spray and/or a lot more power. This spray valve gets heavy. In terms of design, the spray head is too narrow and it's hard to rest it. I have to use this one more. I use circle motions continuously to clean off plates (more than usual). I have to scrub more with this spray valve. It's not the worst but it's not great and I wouldn't buy it. | This spray valve is heavier and harder to squeeze. I like Valve B better than Valve E. I was very unhappy with this spray valve. | I think I used less water because it was quick to clean the plates. It was very easy to clean the dishes. |
| ERG Notes | None. | None. | None. | None. |

**Table D-15. Buckingham Browne & Nichols School User Satisfaction Survey Responses – Pre-Rinse Spray Valves Tested Briefly on Last Day of Study**

| Buckingham Browne & Nichols School[19] | | | | | | |
|---|---|---|---|---|---|---|
| **PRSV Category - PRSV** | **How satisfied are you?** | **How satisfied are you with the pressure?** | **How satisfied are you with the ability to clean the dishes?** | **How satisfied are you with the dish sprayer's pattern?** | **Would you purchase?** | **What do you like/dislike?** |
| 3 - A | 1 | 1 | 1 | 1 | No. | No pressure. Nothing is good. |
| 3 - J | 1 | 1 | 1 | 2 | No. | No pressure. The spray pattern is okay. |
| 3 - H | 2 | 2 | 2 | 2 | Yes. | The pattern is good. The pressure is okay, but not great. |
| 2- I | 2 | 2 | 2 | 2 | Yes. | The pattern is okay. The pressure is okay, not bad. |
| 2 - G | 2 | 2 | 2 | 2 | Yes. | It's pretty good. It has decent pressure. It can clean and reach very far away. It would work. I like the distance it goes. |
| 1 - K | 1 | 1 | 1 | 1.5 | No. | No pressure. The spray pattern is okay. |
| 1- D | 3 | 3 | 3 | 3 | Yes, absolutely. | I like everything. The spray pattern is good. I like the direct spray better but the shower spray pattern is good. |

[19] The operator at Buckingham Browne & Nichols was particularly interested in the study and wanted to evaluate additional PRSV models. On the last day of the study, he evaluated several additional models for one to two minutes each and answered the questions provided in this table. Though this data was collected and is provided here, it was not used in the overall user satisfaction average for each PRSV model because this operator did not evaluate each model for an entire three-week period.

## Table D-16. Buckingham Browne & Nichols School Facility Operations Survey Responses

| Questions | Responses |
|---|---|
| Typical hours of facility operation | 7–9 a.m., 10:30 a.m.–1:15 p.m. |
| General type of food the facility serves for each mealtime | Various cuisine for continental breakfast and lunch |
| Number of customers served and/or volume of dishes washed (per day, per week) | Provided in data tables above |
| Any information about atypical business (i.e., special events) | None |
| Whether water is heated by electricity, natural gas, or other means | Natural Gas |
| Whether PRSVs use hot water, cold water, or both | Both |
| Whether a mixing valve on the faucet feeds the PRSV | No |
| How long the spray valves usually last and/or how frequently they are replaced | Not answered |
| Any changes in the type of food served | None |

## Table D-17. Farmers & Fishers Data

| Farmers & Fishers | | | | |
|---|---|---|---|---|
| PRSV | X | G | F | J |
| PRSV | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| Flow rate category (1 = high, 2 = mid, 3 = low) | 2 | 2 | 1 | 3 |
| Spray pattern | Fan | Fan | Shower | Straight |
| Week | Weeks 1–3 | Weeks 4–6 | Weeks 7–9 | Weeks 10–12 |
| Total days used (days) | 20.93 | 20.62 | 20.83 | 20.50 |
| Total customer count | 8,021 | 9,038 | 10,743 | 11,424 |
| **WATER USED** | | | | |
| Total water used (gallons) | 4167.8 | 5821.0 | 6492.0 | 3458.1 |
| Water used per day (gallons per day) | 199.2 | 282.3 | 311.6 | 168.7 |
| **TIME USED** | | | | |
| Total time used (minutes) | 3818.6 | 4215.1 | 4189.3 | 4144.3 |
| Time used per day (minutes per day) | 182.5 | 204.4 | 201.1 | 202.2 |
| **DATA MEASURED WEEKLY** | | | | |
| Operating static water pressure (psi) | 62 | 62 | NC | 63 |
| Operating flowing water pressure (psi) | 55 | 55 | NC | 61 |
| Maximum static water pressure (psi) | NC | 62 | NC | 63 |
| Maximum flowing water pressure (psi) | NC | 56 | NC | 60 |
| Operating water temperature (°F) | 126.1 | 129.2 | 127.0 | 122.2 |
| Cold water temperature (°F) | 49.7 | 74.7 | 74.6 | 86.7 |
| Hot water temperature (°F) | 131.4 | 140.9 | 128.0 | 123.8 |
| Operating measured flow rate (gpm) | 1.17 | 1.41 | 1.54 | 0.79 |
| Maximum measured flow rate (gpm) | NC | 1.39 | 1.55 | 0.80 |
| Cleanability | N/A | 23 | 21 | 21 |
| **USER SATISFACTION** | | | | |
| Overall user satisfaction (1 = unsatisfied, 2 = somewhat satisfied, 3 = completely satisfied) | 2 | 3 | 3 | 1 |

NC – Not collected.
Blue highlight designates the PRSV the user selected to keep.

**NOTES:**
Farmers & Fishers is a restaurant located in downtown Washington, D.C., that serves breakfast, lunch, and dinner seven days a week. It is a Green Living Consulting Certified Green Business, serving American fare sourced from sustainable agriculture.

The last installed valve, originally Valve H, was experiencing leaking at the handle. The valve was removed after one week of use and was replaced with Valve J, which was kept in for the final two weeks of monitoring. Because of this, Valve J was monitored for only two weeks. A third week has been proxied in from the averaged results of weeks 11 and 12 for the purposes of comparing between three-week time periods.

## Table D-18. Farmers & Fishers User Satisfaction Survey Responses

| Farmers & Fishers | | | | |
|---|---|---|---|---|
| **User Information** | Two users at Farmers & Fishers were interviewed: one for the baseline monitoring and the 3rd new valve, the other for the 1st and 2nd new valves. Both are native Spanish speakers. The survey was administered to them verbally in Spanish. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | X | G | F | J |
| **Overall Satisfaction Score Based on All Responses** | 2 | 3 | 3 | 1 |
| **Responses Provided By** | **User 1** | **User 2** | **User 2** | **User 1** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| How satisfied are you with the spray valve? If unsatisfied, explain. | 1 | 3 | 2 | 1 |
| How satisfied are you with the spray valve's pressure? If unsatisfied, was it too strong, too weak, produced excessive backsplash, produced misting, other? | 1 (The valve sprays too slowly; the water pressure is too low.) | 3 | 3 | 2 (A little weak.) |
| How satisfied are you with the dish sprayer's ability to clean the dishes? If unsatisfied, was it too slow, too fast, other? | 3 | 3 | 3 | 2 |
| How satisfied are you with the spray valve's spray pattern? If unsatisfactory, was it too wide, too focused, non-uniform coverage, required modified use pattern, other? | 3 | 3 | 2 | 3 |
| Do you have to adjust the water temperature when using this spray valve? If so, did you make it hotter or colder? Why? | No. | Yes, sometimes the water is very cold and I have to adjust the temperature to make it hotter. | No. | Sometimes. |
| If you were making the purchasing decision, would you buy this spray valve? | No. | Yes. | Yes. | No. |

## Table D-18. Farmers & Fishers User Satisfaction Survey Responses

| Farmers & Fishers | | | | |
|---|---|---|---|---|
| **User Information** | Two users at Farmers & Fishers were interviewed: one for the baseline monitoring and the 3rd new valve, the other for the 1st and 2nd new valves. Both are native Spanish speakers. The survey was administered to them verbally in Spanish. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | X | G | F | J |
| **Overall Satisfaction Score Based on All Responses** | 2 | 3 | 3 | 1 |
| **Responses Provided By** | **User 1** | **User 2** | **User 2** | **User 1** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| What do you like about this spray valve? | Water is sufficiently hot when it comes out of the spray valve and cleans the plates pretty well. | Everything. | I like the force of the water. | I like that the trigger can be locked into place. |
| What do you dislike about this spray valve? | There is not enough pressure. | Nothing. | Nothing. | It is difficult to fully engage and hold down the handle. |
| What type of food/residue is particularly hard to clean from plates with this spray valve? | Desserts. | Eggs. | Eggs. | Cheese and chocolate. |
| Do you ever use something to hold the spray valve in the on position so it is constantly spraying (rather than manually holding it on)? If so, what do you use to hold it on and how often do you do this? | No; manually hold the spray valve. | I only wash dishes by hand. | I only wash dishes by hand. | NA |
| What type of dishes do you wash daily (e.g. mostly plates, pots and pans, utensils)? | A little bit of everything. | NA | NA | NA |
| Do you typically clean dishes separately or in a rack? If difference for different dishes, please explain. | I wash dishes both separately and all together in the rack. | NA | NA | NA |

## Table D-18. Farmers & Fishers User Satisfaction Survey Responses

| Farmers & Fishers | | | | |
|---|---|---|---|---|
| **User Information** | Two users at Farmers & Fishers were interviewed: one for the baseline monitoring and the 3rd new valve, the other for the 1st and 2nd new valves. Both are native Spanish speakers. The survey was administered to them verbally in Spanish. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | X | G | F | J |
| **Overall Satisfaction Score Based on All Responses** | 2 | 3 | 3 | 1 |
| **Responses Provided By** | **User 1** | **User 2** | **User 2** | **User 1** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| How completely do you rinse the dishes? Is your dishwasher effective in removing waste missed by the spray valve? | The plates have to be well-rinsed before they go into the dishwasher. | NA | NA | NA |
| Additional Comments | None. | None. | None. | None. |
| ERG Notes | This spray valve was leaking slightly from the face of the valve. | | | |

## Table D-19. Farmers & Fishers Facility Operations Survey Responses

| Questions | Responses |
|---|---|
| Typical hours of facility operation | Monday–Thursday: 11:30 a.m.–10 p.m., Friday–Saturday: 11:30 a.m.–11 p.m., Sunday: 10 a.m.–10 p.m. Facility typically opens three hours prior to beginning of service and stays open an hour after service. |
| General type of food the facility serves for each mealtime | American fare sourced from sustainable agriculture for lunch and dinner |
| Number of customers served and/or volume of dishes washed (per day, per week) | Provided in data tables above |
| Any information about atypical business (i.e., special events) | It closes occasionally for private events. |
| Whether water is heated by electricity, natural gas, or other means | Electric |
| Whether PRSVs use hot water, cold water, or both | Both |
| Whether a mixing valve on the faucet feeds the PRSV | No |
| How long the spray valves usually last and/or how frequently they are replaced | Installed when the restaurant opened in June 2009. Not yet replaced. |
| Any changes in the type of food served | None |

## Table D-20. Founding Farmers Data

| Founding Farmers | | | | |
|---|---|---|---|---|
| PRSV | K | F | E | L |
| PRSV | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| Flow rate category (1 = high, 2 = mid, 3 = low) | 1 | 1 | 3 | 2 |
| Spray pattern | Fan | Shower | Fan | Fan |
| Week | Weeks 1–3 | Weeks 4–6 | Weeks 7–9 | Weeks 10–12 |
| Total days used (days) | 17.78 | 17.63 | 17.85 | 17.93 |
| Total customer count | 17,301 | 16,653 | 18,384 | 17,901 |
| **WATER USED** | | | | |
| Total water used (gallons) | 3520.7 | 3383.1 | 4898.8 | 4200.3 |
| Water used per day (gallons per day) | 198.0 | 191.9 | 274.5 | 234.3 |
| **TIME USED** | | | | |
| Total time used (minutes) | 3195.7 | 2771.7 | 3157.5 | 4030.8 |
| Time used per day (minutes per day) | 179.7 | 157.2 | 176.9 | 224.9 |
| **DATA MEASURED WEEKLY** | | | | |
| Operating static water pressure (psi) | 58 | NC | 58 | 59 |
| Operating flowing water pressure (psi) | 42 | NC | 44 | 51 |
| Maximum static water pressure (psi) | NC | NC | NC | 61 |
| Maximum flowing water pressure (psi) | NC | NC | NC | 55 |
| Operating water temperature (°F) | 119.2 | 106.1 | 112.8 | 109.8 |
| Cold water temperature (°F) | 93.1 | 99.3 | 98.0 | 93.9 |
| Hot water temperature (°F) | 119.8 | 99.4 | 122.0 | 114.0 |
| Operating measured flow rate (gpm) | 1.10 | 1.19 | 1.62 | 1.07 |
| Maximum measured flow rate (gpm) | 1.21 | 1.19 | 1.72 | 1.09 |
| Cleanability | 17 | 21 | 25 | 23 |
| **USER SATISFACTION** | | | | |
| Overall user satisfaction (1 = unsatisfied, 2 = somewhat satisfied, 3 = completely satisfied) | 3 | 3 | 3 | 2 |

NC – Not collected.
Orange highlight indicates that the PRSV malfunctioned during study.

**NOTES:**
Founding Farmers is a restaurant located in downtown Washington, D.C., that serves breakfast, lunch, and dinner seven days a week. It is a Leadership in Energy and Environmental Design (LEED®) Gold certified restaurant and a Certified Green Restaurant, serving American fare sourced from sustainable agriculture.

Shut-off valves at the facility did not work so no pressure readings could be taken for most of the study.

A leak occurred in Valve E in the final week of monitoring. This leak has been accounted for in the data analysis. ERG determined the average flow rate of the leak and subtracted it from the affected data set.

The dishguard bumper fell off of Valve L during the monitoring period. The valve could still perform and the entire data set was collected.

## Table D-21. Founding Farmers User Satisfaction Survey Responses

| Founding Farmers | | | | |
|---|---|---|---|---|
| **User Information** | Three different users were interviewed at Founding Farmers. All are native Spanish speakers. The survey was administered to them verbally in Spanish. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | K | F | E | L |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 3** | **User 3** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| How satisfied are you with the spray valve? If unsatisfied, explain. | 3 | 3 | 3 | 2 |
| How satisfied are you with the spray valve's pressure? If unsatisfied, was it too strong, too weak, produced excessive backsplash, produced misting, other? | 3 | 3 | 3 | 2 |
| How satisfied are you with the dish sprayer's ability to clean the dishes? If unsatisfied, was it too slow, too fast, other? | 3 | 2 (The water pressure was a bit low.) | 3 | 3 |
| How satisfied are you with the spray valve's spray pattern? If unsatisfactory, was it too wide, too focused, non-uniform coverage, required modified use pattern, other? | 3 | 3 (I prefer the spray formation on this spray valve to the previous one.) | 3 | 2 |
| Do you have to adjust the water temperature when using this spray valve? If so, did you make it hotter or colder? Why? | No, I don't have to change the water temperature. I just keep it at the normal temperature. | No. | No. | No. |
| If you were making the purchasing decision, would you buy this spray valve? | Yes. | Yes. | Yes. | Yes. |

## Table D-21. Founding Farmers User Satisfaction Survey Responses

| Founding Farmers | | | | |
|---|---|---|---|---|
| **User Information** | Three different users were interviewed at Founding Farmers. All are native Spanish speakers. The survey was administered to them verbally in Spanish. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | K | F | E | L |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 3** | **User 3** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| What do you like about this spray valve? | It works well even though we are working almost the entire day. | I like the grip of the spray valve. The handle is oriented differently than the previous spray valve and is easier to use and more comfortable. | Works well. | Comfortable handle. |
| What do you dislike about this spray valve? | No, it's good. | None. | None. | Nothing. |
| What type of food/residue is particularly hard to clean from plates with this spray valve? | It's all about the same. In order to clean the plate well, you simply have to maintain the right pressure. | It doesn't make a difference. What really matters is how long the food has been sitting on the dishes. | No. | Eggs. |
| Do you ever use something to hold the spray valve in the on position so it is constantly spraying (rather than manually holding it on)? If so, what do you use to hold it on and how often do you do this? | This latch is only used to maintain the spray valve open. But we can't do that because in this case we're only allowed to do it by end. | No. | No. | No. |

## Table D-21. Founding Farmers User Satisfaction Survey Responses

| Founding Farmers | | | | |
|---|---|---|---|---|
| **User Information** | Three different users were interviewed at Founding Farmers. All are native Spanish speakers. The survey was administered to them verbally in Spanish. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | K | F | E | L |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 3** | **User 3** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| What type of dishes do you wash daily (e.g. mostly plates, pots and pans, utensils)? | Mostly plates and prep dishware (mixing bowls, large plastic containers, etc.). Silverware gets washed elsewhere. | NA | NA | NA |
| Do you typically clean dishes separately or in a rack? If difference for different dishes, please explain. | We use racks. | NA | NA | NA |
| How completely do you rinse the dishes? Is your dishwasher effective in removing waste missed by the spray valve? | I wash them pretty completely. The water in the dishwasher has to be changed often to prevent food residue buildup. | NA | NA | NA |
| Additional Comments | | | | |

## Table D-21. Founding Farmers User Satisfaction Survey Responses

| Founding Farmers | | | | |
|---|---|---|---|---|
| **User Information** | Three different users were interviewed at Founding Farmers. All are native Spanish speakers. The survey was administered to them verbally in Spanish. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | K | F | E | L |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 3** | **User 3** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| ERG Notes | | | This spray valve broke during the last week of its monitoring and had a significant leak. A new spray valve (same model) was brought in to conduct the user satisfaction survey, but it was done at the end of the study rather than after week 9. The late survey may have impacted the user satisfaction results. | |

## Table D-22. Founding Farmers Facility Operations Survey Responses

| Questions | Responses |
|---|---|
| Typical hours of facility operation | Monday: 8 a.m.–10 p.m., Tuesday–Thursday: 8 a.m.-11 p.m., Friday: 8 a.m.–12 p.m., Saturday: 9 a.m.–12 a.m., Sunday: 9 a.m.–10 p.m. Facility typically opens three hours prior to service and stays open an hour after service. |
| General type of food the facility serves for each mealtime | American fare sourced from sustainable agriculture for breakfast, lunch, and dinner |
| Number of customers served and/or volume of dishes washed (per day, per week) | Provided in data tables above |
| Any information about atypical business (i.e., special events) | It closes occasionally for private events. |
| Whether water is heated by electricity, natural gas, or other means | Natural Gas |
| Whether PRSVs use hot water, cold water, or both | Both |
| Whether a mixing valve on the faucet feeds the PRSV | No |
| How long the spray valves usually last and/or how frequently they are replaced | Installed when the restaurant opened in September 2008. Not yet replaced. |
| Any changes in the type of food served | None |

## Table D-23. Jimmy's Steer House Data

| Jimmy's Steer House | | | | |
|---|---|---|---|---|
| PRSV | Z3 | D | A | I |
| PRSV | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| Flow rate category (1 = high, 2 = mid, 3 = low) | N/A | 1 | 3 | 2 |
| Spray pattern | Shower | Shower | Fan | Fan |
| Week | Weeks 1–3 | Weeks 4–6 | Weeks 7–9 | Weeks 10–12 |
| Total days used (days) | 20.93 | 20.76 | 20.90 | 20.94 |
| Total customer count | 16,136 | 16,584 | 15,779 | 16,065 |
| **WATER USED** | | | | |
| Total water used (gallons) | 5253.6 | 2489.2 | 1210.0 | 2515.2 |
| Water used per day (gallons per day) | 251.0 | 119.9 | 57.9 | 120.1 |
| **TIME USED** | | | | |
| Total time used (minutes) | 2036.0 | 1953.1 | 1866.3 | 2353.6 |
| Time used per day (minutes per day) | 97.3 | 94.1 | 89.3 | 112.4 |
| **DATA MEASURED WEEKLY** | | | | |
| Operating static water pressure (psi) | 67 | 68 | 62 | 65 |
| Operating flowing water pressure (psi) | 39 | 53 | 57 | 55 |
| Maximum static water pressure (psi) | 67 | 69 | 62 | 64 |
| Maximum flowing water pressure (psi) | 43 | 55 | 56 | 55 |
| Operating water temperature (°F) | 74.8 | 82.6 | 86.6 | 83.7 |
| Cold water temperature (°F) | 52.4 | 58.7 | 61.4 | 66.7 |
| Hot water temperature (°F) | 154.4 | 149.3 | 135.4 | 136.1 |
| Operating measured flow rate (gpm) | 2.62 | 1.35 | 0.65 | 1.14 |
| Maximum measured flow rate (gpm) | 2.66 | 1.40 | 0.67 | 1.15 |
| Cleanability | N/A | 21 | 21 | 22 |
| **USER SATISFACTION** | | | | |
| User 1's overall user satisfaction (1 = unsatisfied, 2 = somewhat satisfied, 3 = completely satisfied) | 3 | 3 | 1 | 2 |
| User 2's overall user satisfaction (1 = unsatisfied, 2 = somewhat satisfied, 3 = completely satisfied) | 3 | 3 | NC | 3 |

NC – Not collected.
Blue highlight designates the PRSV the users selected to keep.

**NOTES:**
Jimmy's Steer House is a steak house in the Boston area that is open for lunch and dinner seven days a week.

A water ban was in effect in Boston during the second new valve's monitoring period. Residents in the area were not supposed to drink any of the water without boiling it during this time.

## Table D-24. Jimmy's Steer House User Satisfaction Survey Responses

| Jimmy's Steer House | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Jimmy's Steer House. Both worked the morning/afternoon shift. User 1 speaks Haitian Creole as a first language, French as a second, and some English as a third. User 2 speaks Portuguese. The study was verbally conducted with User 1 in French. User 2 took the survey in written form in Portuguese. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z3 | | D | | A | | I | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 1 | NA | 2 | 3 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| How satisfied are you with the spray valve? If unsatisfied, explain. | 2 | 3 | 3 | 3 | 1 | NA | 2 | 3 |
| How satisfied are you with the spray valve's pressure? If unsatisfied, was it too strong, too weak, produced excessive backsplash, produced misting, other? | 3 | 3 | 3 | 3 | 1 | NA | 2 | 3 |
| How satisfied are you with the dish sprayer's ability to clean the dishes? If unsatisfied, was it too slow, too fast, other? | 3 | 3 | 3 (It has good pressure.) | 3 | 1 | NA | 1 (Slow.) | 3 |

## Table D-24. Jimmy's Steer House User Satisfaction Survey Responses

| Jimmy's Steer House | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Jimmy's Steer House. Both worked the morning/afternoon shift. User 1 speaks Haitian Creole as a first language, French as a second, and some English as a third. User 2 speaks Portuguese. The study was verbally conducted with User 1 in French. User 2 took the survey in written form in Portuguese. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z3 | | D | | A | | I | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 1 | NA | 2 | 3 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| How satisfied are you with the spray valve's spray pattern? If unsatisfactory, was it too wide, too focused, non-uniform coverage, required modified use pattern, other? | 2 | 3 | 3 (It's good.) | 3 | 2 | NA | 2 | 3 |
| Do you have to adjust the water temperature when using this spray valve? If so, did you make it hotter or colder? Why? | It works better with hot water. I don't use cold as much. | No. | Same as before. | No. | No. | NA | No. | No. |
| If you were making the purchasing decision, would you buy this spray valve? | NA | Yes. | Yes. | Yes. | No. | NA | Maybe, it's okay. | Yes. |
| What do you like about this spray valve? | It sprays well. | Okay, no problem. | Good pressure. | Everything. | No good, no pressure. | NA | It's good/okay. | It's good. |

## Table D-24. Jimmy's Steer House User Satisfaction Survey Responses

| Jimmy's Steer House | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Jimmy's Steer House. Both worked the morning/afternoon shift. User 1 speaks Haitian Creole as a first language, French as a second, and some English as a third. User 2 speaks Portuguese. The study was verbally conducted with User 1 in French. User 2 took the survey in written form in Portuguese. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z3 | | D | | A | | I | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 1 | NA | 2 | 3 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| What do you dislike about this spray valve? | Nothing, it's okay. | I like it. | Nothing, it's good. | Nothing. | No pressure. | NA | Nothing. | Nothing. |
| What type of food/residue is particularly hard to clean from plates with this spray valve? | Everything is fine when the water is hot. | Cheese. | Everything is cleaned off, nothing. | NA | Nothing. | NA | Cheese. | Nothing. |
| Do you ever use something to hold the spray valve in the on position so it is constantly spraying (rather than manually holding it on)? If so, what do you use to hold it on and how often do you do this? | No, but others keep it on all the time. The handle is broken. | Yes. | No. | No, just my hands. | No. | NA | No. | No. |
| What type of dishes do you wash daily (e.g. mostly plates, pots and pans, utensils)? | Pots, plates, cups, pans. | Yes. | NA | NA | NA | NA | NA | NA |

## Table D-24. Jimmy's Steer House User Satisfaction Survey Responses

| Jimmy's Steer House | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Jimmy's Steer House. Both worked the morning/afternoon shift. User 1 speaks Haitian Creole as a first language, French as a second, and some English as a third. User 2 speaks Portuguese. The study was verbally conducted with User 1 in French. User 2 took the survey in written form in Portuguese. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z3 | | D | | A | | I | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 1 | NA | 2 | 3 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| Do you typically clean dishes separately or in a rack? If difference for different dishes, please explain. | I use a rack for the machine. I rinse the dishes then put them in a rack for the machine. I wash cups in a rack. | No. | NA | NA | NA | NA | NA | NA |
| How completely do you rinse the dishes? Is your dishwasher effective in removing waste missed by the spray valve? | The dishwasher rinses the dishes pretty well; it is very hot. Nothing is left on the plates. | Yes. | NA | NA | NA | NA | NA | NA |
| Additional Comments | None. | None. | None. | None. | None. | None. | None. | None. |
| ERG Notes | None. | None. | None. | None. | None. | None. | None. | None. |

## Table D-25. Jimmy's Steer House Facility Operations Survey Responses

| Questions | Responses |
|---|---|
| Typical hours of facility operation | Monday–Thursday: 11:15 a.m.–9:30 p.m., Friday–Saturday: 11:15 a.m.–10 p.m., Sunday: 12 p.m.–9 p.m. |
| General type of food the facility serves for each mealtime | Steakhouse cuisine for lunch and dinner |
| Number of customers served and/or volume of dishes washed (per day, per week) | Provided in data tables above |
| Any information about atypical business (i.e., special events) | During the baseline monitoring period, the restaurant was slow during the Easter holiday; the customer count was probably down 500 from normal. A water ban was in effect in Boston during the second new valve monitoring period. |
| Whether water is heated by electricity, natural gas, or other means | Natural Gas |
| Whether PRSVs use hot water, cold water, or both | Both |
| Whether a mixing valve on the faucet feeds the PRSV | No |
| How long the spray valves usually last and/or how frequently they are replaced | 3–6 months |
| Any changes in the type of food served | None |

## Table D-26. Mario's Italian Restaurant Data

| Mario's Italian Restaurant | | | | |
|---|---|---|---|---|
| PRSV | Z4 | G | F | J |
| PRSV | Existing | 1st New Valve | 2nd New Valve | 4th New Valve |
| Flow rate category (1 = high, 2 = mid, 3 = low) | 1 | 2 | 1 | 3 |
| Spray pattern | Shower | Fan | Shower | Jet |
| Week | Weeks 1–3 | Weeks 4–6 | Weeks 7–9 | Weeks 12–14 |
| Total days used (days) | 20.89 | 20.89 | 20.97 | 20.79 |
| Total customer count | 4,615 | 4,789 | 5,263 | 4,915 |
| **WATER USED** | | | | |
| Total water used (gallons) | 3082.5 | 1497.5 | 1755.3 | 685.7 |
| Water used per day (gallons per day) | 147.5 | 71.7 | 83.7 | 33.0 |
| **TIME USED** | | | | |
| Total time used (minutes) | 762.3 | 904.3 | 1000.5 | 1033.1 |
| Time used per day (minutes per day) | 36.5 | 43.3 | 47.7 | 49.7 |
| **DATA MEASURED WEEKLY** | | | | |
| Operating static water pressure (psi) | NC | 91 | 82 | 88 |
| Operating flowing water pressure (psi) | NC | 73 | 68 | 83 |
| Maximum static water pressure (psi) | 91 | 91 | 82 | 88 |
| Maximum flowing water pressure (psi) | 48 | 79 | 71 | 84 |
| Operating water temperature (°F) | 84.6 | 85.9 | 76.1 | 69.0 |
| Cold water temperature (°F) | 49.2 | 56.6 | 60.2 | 66.3 |
| Hot water temperature (°F) | 107.3 | 106.0 | 102.8 | 103.3 |
| Operating measured flow rate (gpm) | 4.31 | 1.75 | 1.88 | 0.78 |
| Maximum measured flow rate (gpm) | 4.37 | 1.78 | 1.90 | 0.77 |
| Cleanability | NA | 23 | 21 | 21 |
| **USER SATISFACTION** | | | | |
| User 1's overall user satisfaction (1 = unsatisfied, 2 = somewhat satisfied, 3 = completely satisfied) | 3 | 3 | 3 | 2 |
| User 2's overall user satisfaction (1 = unsatisfied, 2 = somewhat satisfied, 3 = completely satisfied) | 3 | 3 | 3 | 2 |

NC – Not collected.
Blue highlight designates the PRSV the users selected to keep.

**NOTES:**
Mario's Italian Restaurant is an Italian restaurant in the Boston area that serves lunch and dinner seven days a week.

A water ban was in effect in Boston during the second new valve's monitoring period. Residents in the area were not supposed to drink any of the water without boiling it during this time.

Valve N was installed as the third valve, but during the second week's visit, water was spraying out of the ring around the spray nozzle (between the spray face plate and the dishguard bumper). During the second week, Valve J was installed and a new three-week test period was initiated.

## Table D-27. Mario's Italian Restaurant User Satisfaction Survey Responses

| Mario's Italian Restaurant | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Mario's Italian Restaurant. Both worked the morning/afternoon shift. Both were native Spanish speakers. User 1 also spoke fairly good English. The users took the survey in Spanish in written form, and User 1 would sometimes provide verbal feedback on the spray valves in addition to the written survey. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z4 | | G | | F | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| How satisfied are you with the spray valve? If unsatisfied, explain. | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| How satisfied are you with the spray valve's pressure? If unsatisfied, was it too strong, too weak, produced excessive backsplash, produced misting, other? | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| How satisfied are you with the dish sprayer's ability to clean the dishes? If unsatisfied, was it too slow, too fast, other? | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |

## Table D-27. Mario's Italian Restaurant User Satisfaction Survey Responses

| Mario's Italian Restaurant | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Mario's Italian Restaurant. Both worked the morning/afternoon shift. Both were native Spanish speakers. User 1 also spoke fairly good English. The users took the survey in Spanish in written form, and User 1 would sometimes provide verbal feedback on the spray valves in addition to the written survey. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z4 | | G | | F | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| How satisfied are you with the spray valve's spray pattern? If unsatisfactory, was it too wide, too focused, non-uniform coverage, required modified use pattern, other? | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| Do you have to adjust the water temperature when using this spray valve? If so, did you make it hotter or colder? Why? | No. | No. | No. | NA | No. | No. | No. | No. |
| If you were making the purchasing decision, would you buy this spray valve? | Yes. | Yes. | Yes. | Yes. | Yes. | Yes. | No. | No. |
| What do you like about this spray valve? | Everything is okay. | Everything. | Everything. | Everything. | Everything. | NA | NA | NA |

## Table D-27. Mario's Italian Restaurant User Satisfaction Survey Responses

| Mario's Italian Restaurant | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Mario's Italian Restaurant. Both worked the morning/afternoon shift. Both were native Spanish speakers. User 1 also spoke fairly good English. The users took the survey in Spanish in written form, and User 1 would sometimes provide verbal feedback on the spray valves in addition to the written survey. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z4 | | G | | F | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| What do you dislike about this spray valve? | It's okay. | Nothing. | Nothing. | Nothing. | Nothing. | Nothing. | It is too weak. | It is very weak. |
| What type of food/residue is particularly hard to clean from plates with this spray valve? | Melted cheese, dry sauce. | Nothing. | Cheese. | Cheese. | None. | Cheese. | Cheese. | Cheese. |
| Do you ever use something to hold the spray valve in the on position so it is constantly spraying (rather than manually holding it on)? If so, what do you use to hold it on and how often do you do this? | No. | No. | No. | No. | No. | No. | No. | No. |
| What type of dishes do you wash daily (e.g. mostly plates, pots and pans, utensils)? | Plates. | Plates. | NA | NA | NA | NA | NA | NA |

## Table D-27. Mario's Italian Restaurant User Satisfaction Survey Responses

| Mario's Italian Restaurant | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Mario's Italian Restaurant. Both worked the morning/afternoon shift. Both were native Spanish speakers. User 1 also spoke fairly good English. The users took the survey in Spanish in written form, and User 1 would sometimes provide verbal feedback on the spray valves in addition to the written survey. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z4 | | G | | F | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| Do you typically clean dishes separately or in a rack? If difference for different dishes, please explain. | Yes. | In a rack. | NA | NA | NA | NA | NA | NA |
| How completely do you rinse the dishes? Is your dishwasher effective in removing waste missed by the spray valve? | Yes. | Yes. | NA | NA | NA | NA | NA | NA |

## Table D-27. Mario's Italian Restaurant User Satisfaction Survey Responses

| Mario's Italian Restaurant | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **User Information** | Two users were interviewed at Mario's Italian Restaurant. Both worked the morning/afternoon shift. Both were native Spanish speakers. User 1 also spoke fairly good English. The users took the survey in Spanish in written form, and User 1 would sometimes provide verbal feedback on the spray valves in addition to the written survey. | | | | | | | |
| **PRSV** | Existing | | 1st New Valve | | 2nd New Valve | | 3rd New Valve | |
| **PRSV** | Z4 | | G | | F | | J | |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| **Responses Provided By** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** | **User 1** | **User 2** |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | | | | | |
| Additional Comments | None. | None. | There is a lot of water in the outer spray streams and only a little water in the middle of the stream. It is not uniform. The inside spray is misty while the outside is forceful/straight. | None. | I like the pressure. I can take all of the food off of the plate very nicely. | None. | None. | None. |
| ERG Notes | None. | None. | None. | None. | None. | None. | None. | None. |

## Table D-28. Mario's Italian Restaurant Facility Operations Survey Responses

| Questions | Responses |
|---|---|
| Typical hours of facility operation | Monday–Thursday: 11:15 a.m.–9:30 p.m., Friday–Saturday: 11:15 a.m.–10 p.m., Sunday: 12 p.m.–9 p.m. |
| General type of food the facility serves for each mealtime | Italian cuisine for lunch and dinner |
| Number of customers served and/or volume of dishes washed (per day, per week) | Provided in data tables above |
| Any information about atypical business (i.e., special events) | During the first new valve monitoring period, the restaurant closed one day for Easter. A water ban was in effect in Boston during the second new valve monitoring period, and the restaurant was forced to close for one night, losing 200 customers. |
| Whether water is heated by electricity, natural gas, or other means | Natural Gas |
| Whether PRSVs use hot water, cold water, or both | Both |
| Whether a mixing valve on the faucet feeds the PRSV | No |
| How long the spray valves usually last and/or how frequently they are replaced | Replaced the hose twice in seven years and the PRSV once in seven years |
| Any changes in the type of food served | None |

## Table D-29. The Fireplace Restaurant Data

| The Fireplace Restaurant | | | | |
|---|---|---|---|---|
| PRSV | D | K | H | B |
| PRSV | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| Flow rate category (1 = high, 2 = mid, 3 = low) | 1 | 1 | 3 | 2 |
| Spray pattern | Shower | Fan | Jet | Fan |
| Week | Weeks 1–3 | Weeks 4–6 | Weeks 7–9 | Weeks 10–12 |
| Total days used (days) | 20.88 | 20.95 | 20.90 | 20.94 |
| Total customer count | 3,700 | 3,550 | 3,692 | 3,698 |
| **WATER USED** | | | | |
| Total water used (gallons) | 1676.7 | 1733.2 | 1380.8 | 1726.5 |
| Water used per day (gallons per day) | 80.3 | 82.7 | 66.1 | 82.5 |
| **TIME USED** | | | | |
| Total time used (minutes) | 1580.2 | 1579.7 | 1693.8 | 1217.8 |
| Time used per day (minutes per day) | 75.7 | 75.4 | 81.0 | 58.2 |
| **DATA MEASURED WEEKLY** | | | | |
| Operating static water pressure (psi) | 73 | 71 | 68 | 66 |
| Operating flowing water pressure (psi) | 59 | 52 | 54 | 43 |
| Maximum static water pressure (psi) | 76 | 73 | 73 | 71 |
| Maximum flowing water pressure (psi) | 63 | 61 | 64 | 55 |
| Operating water temperature (°F) | 113.4 | 123.2 | 113.0 | 121.9 |
| Cold water temperature (°F) | 51.6 | 61.9 | 62.0 | 66.8 |
| Hot water temperature (°F) | 119.2 | 122.6 | 199.3 | 126.1 |
| Operating measured flow rate (gpm) | 1.04 | 1.09 | 0.86 | 1.46 |
| Maximum measured flow rate (gpm) | 1.19 | 1.33 | 0.96 | 1.74 |
| Cleanability | 21 | 17 | 20 | 24 |
| **USER SATISFACTION** | | | | |
| Overall user satisfaction (1 = unsatisfied, 2 = somewhat satisfied, 3 = completely satisfied) | 3 | 3 | 1 | 3 |

NC – Not collected.
Blue highlight designates the PRSV the user selected to keep.
Orange highlight indicates that the PRSV malfunctioned during study.

**NOTES:**
The Fireplace Restaurant is a Certified Green Restaurant that serves American cuisine and is open for lunch and dinner Monday–Friday and for brunch and dinner on Saturday and Sunday.

Valve H began leaking slightly only when the PRSV was depressed sometime during the last week of the data collection for this valve. Water was squirting from the point where the spray handle meets the depression point that allows the valve to open. The user had rigged a plastic glove onto the PRSV to prevent it from spraying him. The leak was not apparent in the data so it was not adjusted.

## Table D-30. The Fireplace Restaurant User Satisfaction Survey Responses

| The Fireplace Restaurant | | | | |
|---|---|---|---|---|
| **User Information** | One user was interviewed at The Fireplace Restaurant. He works the lunch shift. He is a native Spanish speaker and does not speak any English. He took the surveys in written form in Spanish. On the last day, a native Spanish speaker interviewed the user in Spanish on his thoughts on the PRSVs and asked him which valve he wanted to keep. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | D | K | H | B |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 1 | 3 |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| How satisfied are you with the spray valve? If unsatisfied, explain. | 3 | 3 | 1 | 3 |
| How satisfied are you with the spray valve's pressure? If unsatisfied, was it too strong, too weak, produced excessive backsplash, produced misting, other? | 3 | 3 | 3 | 3 |
| How satisfied are you with the dish sprayer's ability to clean the dishes? If unsatisfied, was it too slow, too fast, other? | 3 | 3 | 3 | 3 |
| How satisfied are you with the spray valve's spray pattern? If unsatisfactory, was it too wide, too focused, non-uniform coverage, required modified use pattern, other? | | 3 | 3 | 3 |
| Do you have to adjust the water temperature when using this spray valve? If so, did you make it hotter or colder? Why? | No. | Yes, to cool something. | Yes, to cool something. | Just to cool something. |
| If you were making the purchasing decision, would you buy this spray valve? | Yes. | No. | No. | NA |
| What do you like about this spray valve? | It's strong. | The way it is. | It's strong. | It is good. |
| What do you dislike about this spray valve? | Nothing. | It's strong. | The spray is very straight. | It is good. |

## Table D-30. The Fireplace Restaurant User Satisfaction Survey Responses

| The Fireplace Restaurant | | | | |
|---|---|---|---|---|
| **User Information** | One user was interviewed at The Fireplace Restaurant. He works the lunch shift. He is a native Spanish speaker and does not speak any English. He took the surveys in written form in Spanish. On the last day, a native Spanish speaker interviewed the user in Spanish on his thoughts on the PRSVs and asked him which valve he wanted to keep. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | D | K | H | B |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 1 | 3 |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| What type of food/residue is particularly hard to clean from plates with this spray valve? | Eggs. | Eggs. | Eggs with cheese. | Eggs with cheese. |
| Do you ever use something to hold the spray valve in the on position so it is constantly spraying (rather than manually holding it on)? If so, what do you use to hold it on and how often do you do this? | NA | No. | Nothing. | No. |
| What type of dishes do you wash daily (e.g. mostly plates, pots and pans, utensils)? | Plates. | NA | NA | NA |
| Do you typically clean dishes separately or in a rack? If difference for different dishes, please explain. | Yes. | NA | NA | NA |
| How completely do you rinse the dishes? Is your dishwasher effective in removing waste missed by the spray valve? | Yes. | NA | NA | NA |
| Additional Comments | This spray valve is okay. I felt the same about Valve D and Valve K. | This spray valve is okay. I felt the same about Valve D and Valve K. | This spray valve is my least favorite. It has a small spray pattern. It can knock glasses out of my hand. | I'd like to keep this spray valve. I like it because it has the best spray with a wide breadth. It has good pressure. It was my favorite by far. |

## Table D-30. The Fireplace Restaurant User Satisfaction Survey Responses

| The Fireplace Restaurant | | | | |
|---|---|---|---|---|
| **User Information** | One user was interviewed at The Fireplace Restaurant. He works the lunch shift. He is a native Spanish speaker and does not speak any English. He took the surveys in written form in Spanish. On the last day, a native Spanish speaker interviewed the user in Spanish on his thoughts on the PRSVs and asked him which valve he wanted to keep. | | | |
| **PRSV** | Existing | 1st New Valve | 2nd New Valve | 3rd New Valve |
| **PRSV** | D | K | H | B |
| **Overall Satisfaction Score Based on All Responses** | 3 | 3 | 1 | 3 |
| **KEY: 1 - unsatisfied, 2 - somewhat satisfied, 3 - completely satisfied** | | | | |
| ERG Notes | None. | None. | None. | None. |

## Table D-31. The Fireplace Restaurant Facility Operations Survey Responses

| Questions | Responses |
|---|---|
| Typical hours of facility operation | Sunday–Wednesday: 11 a.m.–10 p.m., Thursday–Saturday: 11 a.m.–11 p.m. |
| General type of food the facility serves for each mealtime | American cuisine for lunch and dinner Monday–Friday and brunch and dinner Saturday–Sunday |
| Number of customers served and/or volume of dishes washed (per day, per week) | Provided in data tables above |
| Any information about atypical business (i.e., special events) | A water ban was in effect in Boston during the second new valve monitoring period, but the spray valve was still used because the dishwasher provided water hot enough to sanitize the dishes. |
| Whether water is heated by electricity, natural gas, or other means | Natural Gas |
| Whether PRSVs use hot water, cold water, or both | Both |
| Whether a mixing valve on the faucet feeds the PRSV | No |
| How long the spray valves usually last and/or how frequently they are replaced | Existing spray valve was installed in 2005 |
| Any changes in the type of food served | None |