WaterSense® Draft Specification for Commercial Pre-Rinse Spray Valves Supporting Statement

I. Introduction

Commercial pre-rinse spray valves (PRSVs) are used in commercial food operations to remove food waste from dishes prior to dishwashing. PRSVs can account for nearly one-third of the water used in the commercial kitchen; about 970,000 food service establishments nationwide use approximately 32 billion gallons of water per year.[1] The U.S. Environmental Protection Agency's (EPA's) WaterSense program released a draft specification for PRSVs to earn the WaterSense label on February 7, 2013, in order to further improve the nation's water and energy efficiency by promoting more efficient PRSVs. The intent of this specification is to help restaurant managers, equipment purchasers, and product users identify products that meet EPA's criteria for water efficiency and performance.

WaterSense collaborated with the American Society of Mechanical Engineers (ASME)/Canadian Standards Association (CSA) Joint Harmonization Task Force Project Team FT-07-11 (hereafter referred to as "project team") to develop the specification criteria for high-efficiency PRSVs. This project team is open to the public and comprises a wide variety of stakeholders, including: PRSV manufacturers; water and energy utilities; testing laboratories; representatives from ASTM International; and consultants and other water-efficiency and conservation specialists. The project team's participation, resources, and expertise enabled WaterSense to evaluate PRSV efficiency and performance and develop meaningful testing protocols that can effectively differentiate PRSV performance.

II. Current Status of Commercial PRSVs

The National Restaurant Association (NRA) estimates that approximately 970,000 commercial food establishments are operating in the United States as of 2012. While many of these establishments might use more than one PRSV, the Food Service Technology Center (FSTC) has noted that the vast majority has only one valve dedicated to pre-rinse functions. WaterSense estimates that based on a five year useful life, approximately 20 percent of the existing 970,000 PRSVs are replaced each year due to wear, remodeling, or other reasons. Theoretically, most existing PRSVs should have flow rates equal to or less than the federal standard of 1.6 gallons per minute (gpm), which was mandated by the Energy Policy Act of 2005 (EPAct 2005). Based on this assumption, with normal replacements and units sold for new applications, WaterSense estimates that approximately 200,000 new PRSVs are sold each year. Since Congress enacted the federal requirements in the mid-2000s, manufacturers have developed PRSVs that use significantly less water than the flow rates established by EPAct 2005. These high-efficiency PRSVs use at least 20 percent less water than standard fixtures, resulting in potential savings of more than 7,000 gallons of water per PRSV per year and nearly 6,200 cubic feet of natural gas that would otherwise be required to heat the water.[2]

[1] Refer to Appendix A for the assumptions and calculations used to derive these estimates.
[2] *Ibid*.

III. WaterSense Draft Specification for Commercial PRSVs

Scope

The draft WaterSense specification applies to commercial PRSVs, which are defined as handheld devices designed and marketed for use with commercial dishwashing and warewashing equipment and applications that spray water on dishes, flatware, and other food service items for the purpose of removing food residue before cleaning the items. A PRSV consists of a spray nozzle, a squeeze lever that controls the water flow, and a dish guard bumper. Some models include a spray handle clip, allowing the user to lock the lever in the full spray position for continual use.

The draft specification does not apply to spray fittings used for pot and kettle filling, pet grooming, grocery produce and meat cleaning, residential dish rinsing, and purposes other than those described in the definition above.

Retrofit devices, including aftermarket flow control devices, are also excluded because the intent of the specification is to recognize and label complete, fully functioning fixtures or fittings, and not individual components.

General Requirements

Some PRSVs are sold with multiple modes to provide the user with options for different spray types (e.g., fan, jet, or multi-stream). To allow for manufacturing flexibility and consumer choice for multiple mode PRSVs, the draft WaterSense specification addresses these types of PRSVs by requiring *all modes* to meet the maximum flow rate requirement and *at least one mode*, as specified by the manufacturer, to meet all the requirements outlined in the specification (e.g., only one mode must meet the spray force, lifecycle, and marking requirements).

Water-Efficiency Criteria

The water-efficiency section of the draft specification establishes a maximum flow rate of 1.28 gpm (4.8 liters per minute [Lpm]). WaterSense determined this flow rate after examining the range of products currently available on the market and receiving a recommendation from the project team. This maximum flow rate represents a 20 percent reduction from the current federally allowable maximum flow rate of 1.6 gpm established by EPAct 2005, which is consistent with WaterSense's stated water-efficiency goal.

Performance Criteria

Background on Performance Test Method Development

Establishing performance-based criteria for WaterSense labeled PRSVs is critical to ensuring user satisfaction and maintaining the integrity of the WaterSense label. Although 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*

F2324-03) was developed. In accordance with the 2003 and reapproved 2009 version of the ASTM test method, PRSV efficiency is determined by measuring flow rate in gpm. Product performance is determined by measuring "cleanability," or the time it takes for the PRSV to rinse tomato paste from a plate, in units of seconds per plate.

During WaterSense's initial evaluation of this product category, EPA received input from some of its utility partners and other stakeholders with concerns about low user satisfaction and longer use time among high-efficiency PRSVs in the field, even though these valves scored well on the *ASTM F2324-03* cleanability test. Stakeholders were concerned that, if high-efficiency PRSVs take users longer to rinse dishes in the field, these PRSVs may save less water and energy than expected. Further, some PRSVs with which utility partners indicated users were not satisfied were scoring well on the cleanability test, which raised concerns about the efficacy of the cleanability test and its use as a tool to assess and differentiate product performance.

Because EPA wants to ensure that the WaterSense label can only be earned by water- and energy-efficient PRSVs that perform as well or better than standard models, WaterSense decided that it needed additional field data on PRSVs before developing a specification. With significant input from the project team, WaterSense developed a field study approach. 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.
- The *ASTM F2324* cleanability test method provides an indication of PRSV performance in the field.

From January through June 2010, EPA monitored PRSV use at 10 commercial and institutional kitchens.[3] 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 F2324-03* test method. At the end of each three-week monitoring period, WaterSense surveyed the PRSV users to assess their satisfaction with each PRSV.

Following the 12-week study, after analyzing all water use, use time, and user satisfaction data, WaterSense concluded the following:

- Users did not use high-efficiency PRSVs for significantly longer than higher flowing models and, as a result, high-efficiency PRSVs did save water and energy.
- Use time did not have a perceivable impact on user satisfaction.
- *ASTM F2324-03* cleanability test results did not correlate with the PRSVs that the users preferred.
- ASTM F2324-03 cleanability test results did not correlate with actual use time in the field.
- Users were generally less satisfied with PRSVs that flowed at less than 1.0 gpm.
- Several users indicated low pressure (i.e., spray force) as a reason for dissatisfaction.

[3] U.S. Environmental Protection Agency's (EPA's) WaterSense program. March 31, 2011. Pre-Rinse Spray Valves Field Study Report. Page 19. www.epa.gov/watersense/products/prsv.html.

WaterSense presented and discussed the field study results and observations with the project team. WaterSense and the project team generally agreed that it should proceed with the development of a specification for high-efficiency PRSVs, but that a new measure of performance was needed since the *ASTM F2324-03* cleanability test does not adequately differentiate PRSV performance and, in particular, users showed dissatisfaction with PRSVs that flowed less than 1.0 gpm.

Initially, WaterSense suggested establishing a minimum flow rate to serve as the performance criteria; however, the project team indicated that a minimum flow rate may stifle manufacturer innovation and further improvements to product efficiency. As an alternative, the project team suggested evaluating spray force as the performance metric, since users overwhelmingly cited it as a reason for dissatisfaction.

As an ancillary observation during the field study, several of the installed models leaked or otherwise malfunctioned during the three-week testing period, causing WaterSense to question the long-term durability and ultimate water and energy savings potential of the products once installed in the field. To address this issue, the project team recommended strengthening the current life cycle testing requirements specified by *ASME A112.18.1/CSA B125.1 Plumbing Supply Fittings* to better ensure product duration and the longevity of water and energy savings.

Draft Specification Performance Criteria: Force

The project team began working to define a repeatable and reproducible measure of spray force that could provide an indication of user satisfaction. The spray force requirements contained in the draft WaterSense specification are a result of these efforts.

Initially borrowing from the concepts for measuring force as specified by the *WaterSense Specification for Showerheads*, the test protocol underwent several iterations of round robin testing in various laboratories by multiple independent, third-party certifiers to refine the protocol. To determine spray force's efficacy as a performance metric, laboratory force test data for the 14 PRSV models monitored in EPA's field study were then compared against the user satisfaction survey data. Ultimately, spray force was found to correlate better to user satisfaction than cleanability. As a result, ASTM is in the process of revising its *ASTM F2324* test protocol to include the new spray force method and remove the cleanability method from the body of the test protocol.

The spray force component of the draft WaterSense specification requires a PRSV's spray force to be at least 5.0 ounces (142 grams) at an inlet pressure of 60 psi when the water is flowing. The testing procedure, described in the draft revisions to *ASTM F2324* (and included in Appendix A of the draft specification), is a direct measure of the force of the PRSV through the use of a force gauge. The PRSV is aimed directly at the force gauge, and the spray force reading is collected.

The minimum spray force of 5.0 ounces in the draft specification represents the lower bound of user satisfaction. This spray force was agreed upon and recommended by the project team after reviewing the spray force data compiled during the laboratory testing and comparing it to user satisfaction data from WaterSense's field study.

Since EPA received the minimum force recommendation from the project team, some stakeholders have approached WaterSense to indicate that requiring a minimum force of 5.0 ounces in the specification may unintentionally exclude PRSVs that are considered satisfactory in some applications. The stakeholders pointed out that WaterSense's field study was conducted in high-use commercial kitchen facilities where food residue is often dried and stuck onto plates, whereas some PRSVs are used in lighter use commercial settings (such as fast food restaurants and coffee shops) where heavy dish soiling is not as significant. In these light-use commercial kitchen facilities, they suggest a PRSV with a lower force might be sufficient and satisfactory.

WaterSense does not currently have data to support reducing the minimum spray force requirement, but welcomes stakeholders to submit written comments, preferably supported by performance data, for EPA to consider related to this requirement. In the case that such data is confidential, it may be submitted as confidential business information (CBI) through EPA's contractor, Eastern Research Group, Inc, as outlined in the draft specification cover letter.

In addition, WaterSense welcomes stakeholder comments regarding how the scope of the draft specification should clarify the PRSV types to which the specification applies and ways to avoid unintentional exclusions of efficient products that may be satisfactory in certain applications.

Draft Specification Criteria: Life Cycle

EPA is interested in making the WaterSense label available for products that are able to perform over the course of their expected useful life and provide the expected water savings over the life of the product. Based upon the high occurrence of breakage and leakage observed during the field study, the project team recommended increasing the life cycle testing requirements from 150,000 cycles, as currently specified in *ASME A112.18.1/CSA B125.1*, to 500,000 cycles. Based on WaterSense's assumptions and calculations provided in Appendix A, this would more realistically approximate the anticipated useful life of PRSVs. Life cycle testing should be done in accordance with the procedures outlined in *ASME A112.18.1/CSA B125.1*.

Marking

To ensure that restaurant managers, equipment purchasers, and product users can make an informed decision for their specific PRSV end use, WaterSense expanded the product and packaging/literature marking requirements for PRSVs. The requirements are designed to clearly indicate the maximum flow rate and minimum spray force of the PRSV. At the outset of the certification process, the manufacturer will specify a maximum flow rate value ("rated" flow rate), not to exceed 1.28 gpm, which is subsequently verified through testing. WaterSense labeling criteria will require the manufacturer to mark the product and also the product packaging and/or product literature with this rated flow rate value, so that the information provided to the consumer is both informative and accurate.

In addition to marking the product and packaging and/or product literature with the maximum rated flow rate, WaterSense labeled product packaging and/or product literature (but not the product itself) will also be required to include the PRSV's spray force. The purpose of this marking requirement is to assist purchasers in understanding the true force of the PRSV so they can make an informed purchase for the intended application.

IV. Potential Savings and Cost Effectiveness

Note: Refer to Appendix A for the assumptions and calculations used to derive these estimates.

Potential Water and Energy Savings

PRSVs with a flow rate of 1.28 gpm or less have the potential to save significant amounts of water and energy at both the facility level and at the national level. Replacing standard PRSVs with WaterSense labeled PRSVs could save more than 7,000 gallons of water per PRSV per year. Based upon the amount of water saved, the average commercial kitchen could save nearly 6,200 cubic feet of natural gas [or more than 1,200 kilowatt hours (kWh) of electricity] that would otherwise be required to heat the water.

Nationwide, if all standard PRSVs were replaced with WaterSense labeled PRSVs, WaterSense estimates that water savings could exceed 6.8 billion gallons of water per year. National energy savings could exceed 3.5 billion cubic feet of natural gas and 410 million kWh of electricity each year.

Cost-Effectiveness

The average food service establishment replacing its PRSVs with WaterSense labeled PRSVs will realize $58 in savings on water and wastewater costs annually due to lower water consumption. Factoring in the accompanying energy savings, the average food service establishment with natural gas water heating could save an additional $55, for a combined annual savings of $113. The average food service establishment with electric water heating could save an additional $131, for a combined annual savings of $189.

If the average PRSV costs $75 retail, the average payback period for the replacement of one standard PRSV per food service establishment with a WaterSense labeled model would be approximately 8 months for those heating water with natural gas and about 5 months for those with electric water heating.

V. Certification and Labeling

WaterSense has established an independent third-party product certification process, described on the WaterSense website at www.epa.gov/watersense/partners/certification.html. Under this process, products are certified to conform to applicable WaterSense specifications by accredited third-party licensed certifying bodies. Manufacturers are then authorized to use the WaterSense label in conjunction with certified products.

VI. Other Items for Consideration

WaterSense and ENERGY STAR®

When EPA released its *Notification of Intent (NOI) to Develop Draft Performance Specifications for High-Efficiency Pre-Rinse Spray Valves*, WaterSense and ENERGY STAR were considering a dual label for PRSVs. At this point in time, EPA has decided that PRSVs will only be eligible for the WaterSense label; however, ENERGY STAR will continue to play an active role in promoting the WaterSense labeled PRSVs, because they offer significant water and energy savings. In addition, it is a conscious decision to provide a streamlined process and ensure that undue burden is not placed on manufacturers seeking to label their products, since the programs have slightly different certification schemes and requirements.

Draft Revised *ASTM F2324*

WaterSense's *Draft Specification for Commercial Pre-Rinse Spray Valves* incorporates the water-efficiency and force test protocols specified in the draft revised A*STM F2324 Standard Test Method for Prerinse Spray Valves*, which is up for ballot through ASTM International in 2012 and 2013. The draft revisions to the *ASTM F2324* test method were developed in conjunction with the project team based upon WaterSense's field study and the project team's laboratory testing data. WaterSense's intent is to reference the final version of the revised *ASTM F2324* test method, once approved.

Appendix A: Calculations and Key Assumptions

Life Cycle Testing Calculations

Assumptions:

- Based on experience in the field study, PRSVs are typically used for 10-second intervals or less. Therefore, one "cycle" is assumed to be 10 seconds.
- Based on use time data from a variety of field studies, WaterSense assumes the average use time of a PRSV is 64 minutes per day.[4]
- Based on manufacturer input, WaterSense assumes a PRSV's expected useful life is 5 years. Experience during WaterSense's field study suggests that the useful life could be longer.
- WaterSense assumes PRSVs are used for 344 days per year on average.[5]

Equation 1. Average PRSV Cycles Per Day

(64 minutes of PRSV use/day x 60 seconds/minute) ÷ 10 seconds/cycle = 384 cycles/day

Equation 2. Average PRSV Cycles Per Year

384 cycles/day x 344 days/year = 132,096 cycles/year

The project team recommended increasing life cycle testing to 500,000 cycles.

Equation 3. Lifetime Represented by 500,000 Cycles

500,000 cycles ÷ 132,096 cycles/year = 4 years

500,000 cycles approaches the expected useful life of 5 years.

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[4] Weighted average use time calculated from the following studies:

- Tso, Bing, P.E. and John Koeller, P.E. December 1, 2005. Pre-Rinse Spray Valve Programs: How Are They Really Doing? Page 8. (Includes results from: California Urban Water Conservation Council's Phase 1 and Phase 2 programs; Veritec Consulting's Region of Waterloo study; a pilot test conducted by Seattle Public Utilities; and a pilot test done by Puget Sound Energy).
- Veritec Consulting, Inc. December 2005. City of Calgary Pre-Rinse Spray Valve Pilot Study Final Report.
- EPA's WaterSense program. March 31, 2011. Pre-Rinse Spray Valves Field Study Report. Appendix D. http://www.epa.gov/watersense/docs/final_epa_prsv_study_report_033111v2_508.pdf.

[5] A Puget Sound Energy direct-installation program characterized the facility types in the PRSV market in the Seattle region. The program indicated that approximately 70 percent of facilities using PRSVs are restaurants, 15 percent are institutional sites (schools, hospitals, and military cafeterias), 9 percent are groceries, and the remaining 6 percent are other establishments such as religious, civic and social organizations, hotels, and motels. Based on this information, WaterSense assumes 85 percent of the facilities using PRSVs are ones that are operated nearly year-round (restaurants, hospitals, military cafeterias, groceries, etc.); and the remaining 15 percent are operated on a traditional 250 days per year working schedule (schools, universities, and other facility types). Source: Tso, Bing, P.E. and John Koeller, P.E. December 1, 2005. Pre-Rinse Spray Valve Programs: How Are They Really Doing? Page 5.

Potential Water Savings Calculations

Assumptions:

- A standard PRSV's rated flow rate is 1.6 gpm, and a WaterSense labeled PRSV's rate flow rate is 1.28 gpm or less. Experience during WaterSense's field study suggests that some existing PRSVs could exceed the national standard of 1.6 gpm. If an establishment has a PRSV with a flow rate higher than 1.6 gpm, water and energy savings will be higher than shown in these calculations.
- Based on use time data from a variety of field studies, WaterSense assumes the average use time of a PRSV is 64 minutes per day.[3]
- WaterSense assumes PRSVs are used for 344 days per year on average.[4]
- As of 2012, there are 970,000 food service establishments in the United States, which have one PRSV each.[6,7]
- An estimated 20 percent of existing PRSVs are replaced each year due to wear, remodeling, or other reasons, based on an estimated useful life of 5 years.
- Based on the total number of food service establishments estimated by the NRA from year to year, WaterSense assumes the food service industry increases in size by 1 percent per year.

Equation 4. Annual Water Savings Potential From Replacing a 1.6 gpm Rated PRSV
(1.6 gpm – 1.28 gpm) x 64 minutes of PRSV use/day x 344 days/year
= 7,045 gallons/PRSV/year

Equation 5. Annual National Water Savings Potential From Replacing All 1.6 gpm PRSVs
7,045 gallons/PRSV/year x 970,000 PRSVs = 6.8 billion gallons/year

Equation 6. Annual National Water Savings Potential From Natural Replacement with WaterSense Labeled PRSVs
7,045 gallons/PRSV/year x 970,000 PRSVs x 20 percent per year = 1.4 billion gallons/year

Equation 7. Annual National Water Savings Potential From Installation of WaterSense Labeled PRSVs in New Applications
7,045 gallons/PRSV/year x 970,000 PRSVs x 1 percent per year = 68 million gallons/year

Potential Energy Savings Calculations

Assumptions:

- WaterSense assumes that PRSVs use 100 percent hot water.
- Water heating consumes 0.18 kWh of electricity per gallon of water heated assuming:
    - o Specific heat of water = 1.0 Btu/lb x º Fahrenheit (F)
    - o 1 gallon of water = 8.34 pounds (lbs)
    - o 1 kWh = 3,412 British thermal units (Btus)

[6] National Restaurant Association. Research & Insights: Facts. <www.restaurant.org/research/facts/>.
[7] Energy Solutions. May 4, 2004. Codes and Standards Enhancement Initiative for PY2004: Title 20 Standards Development, Draft Analysis of Standard Options for Pre-Rinse Spray Valves. Prepared for Gary B. Fernstrom, Pacific Gas and Electric Company. Pages 1-7.

    - Incoming water temperature is raised from 55º F to 120º F (Δ 65 º F)
    - Water heating process is 90 percent efficient for electric hot water heaters
- Water heating consumes 0.0008774 thousand cubic feet (Mcf) of natural gas per gallon of water heated assuming:
    - Specific heat of water = 1.0 Btu/lb x º F
    - 1 gallon of water = 8.34 lbs
    - 1 Therm = 99,976 Btus
    - Incoming water temperature is raised from 55º F to 120º F (Δ 65 º F)
    - Water heating process is 60 percent efficient for natural gas hot water heaters
- Approximately 59 percent of food service establishments use natural gas to heat their hot water, approximately 34 percent use electricity to heat their hot water, and the remaining portion use other sources.[8]

Electricity

Equation 8. KWh Required to Raise 1 Gallon of Water 65º F
[(1.0 Btu/lbs x º F) (1kWh/3,412 Btus) ÷ (1 gallon/8.34 lbs) x 65º F] ÷ 0.90 = 0.18 kWh/gallon

Equation 9. Electricity Saving Potential Per PRSV
7,045 gallons/year x 1.00 percent hot water x 0.18 kWh/gallon = 1,268 kWh of electricity/year

Equation 10. National Electricity Savings Potential From Replacing All 1.6 gpm PRSVs
6.8 billion gallons/year x 1.00 percent hot water x 0.34 percent electricity use x 0.18 kWh/gallon = 416 million kWh of electricity/year nationwide

Equation 11. National Electricity Savings Potential From Natural Replacement with WaterSense Labeled PRSVs
1.4 billion gallons/year x 1.00 percent hot water x 0.34 percent electricity use x 0.18 kWh/gallon = 86 million kWh of electricity/year nationwide

Equation 12. National Electricity Savings Potential From Installation of WaterSense Labeled PRSVs in New Construction
68 million gallons/year x 1.00 percent hot water x 0.34 percent electricity use x 0.18 kWh/gallon = 4.2 million kWh of electricity/year nationwide

Natural Gas

Equation 13. Therms Required to Raise 1 Gallon of Water 65º F
[(1.0 Btu/lbs x º F) (1 Therm/99,976 Btus) ÷ (1 gal/8.34 lbs) x 65º F] ÷ 0.60 = 0.009 Therms/gallon

Equation 14. Converting Therms to Mcf
0.009 Therms/gallon x 1 Mcf/10.307 Therms = 0.0008774 Mcf/gallon

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[8] U.S. Energy Information Administration. 2003 Commercial Building Energy Consumption Survey Detailed Tables. Table B31. <www.eia.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html>.

Equation 15. Natural Gas Savings Potential Per PRSV
7,045 gallons/year x 1.00 percent hot water x 0.0008774 Mcf/gallon
= 6.2 Mcf (6,200 cubic feet) of natural gas/year

Equation 16. National Natural Gas Savings Potential From Replacing All 1.6 gpm PRSVs
6.8 billion gallons/year x 1.00 percent hot water x 0.59 percent electricity use x 0.0008774 Mcf/gallon
= 3.5 million Mcf of natural gas/year nationwide

Equation 17. National Natural Gas Savings Potential From Natural Replacement with WaterSense Labeled PRSVs
1.4 billion gallons/year x 1.00 percent hot water x 0.59 percent electricity use x 0.0008774 Mcf/gallon
= 724,732 Mcf of natural gas/year nationwide

Equation 18. National Natural Gas Savings Potential From Installation of WaterSense Labeled PRSVs in New Construction
68 million gallons/year x 1.00 percent hot water x 0.59 percent electricity use x 0.0008774 Mcf/gallon
= 35,201 Mcf of natural gas/year nationwide

Cost Effectiveness Calculations

Assumptions:

- Price of water supply and wastewater treatment is $8.25/1,000 gallons.[9]
- Price of electricity is $0.1032/kWh.[10]
- Price of natural gas is $8.92/Mcf.[11]

Equation 19. Annual Water and Wastewater Cost Savings per PRSV per Year
7,045 gallons/year x $8.25/1,000 gallons = $58/year

Equation 20. Annual Electricity Cost Savings per PRSV per Year
1,268 kWh/year x $0.1032/kWh = $131/year

Equation 21. Annual Natural Gas Cost Savings per PRSV per Year
6.2 Mcf/year x $8.92/Mcf= $55/year

Equation 22. Annual Water, Wastewater, and Electricity Savings
$58/year water/wastewater savings + $131/year electricity savings = $189/year

Equation 23. Annual Water, Wastewater, and Natural Gas Savings

[9] Raftelis Financial Consulting. Water and Wastewater Rate Survey. American Water Works Association. 2010.
[10] U.S. Energy Information Administration. Short Term Energy Outlook. Electricity. Price Summary Table. <www.eia.gov/forecasts/steo/report/electricity.cfm>.
[11] U.S. Energy Information Administration. Short Term Energy Outlook. Natural Gas. Price Summary Table. <www.eia.gov/forecasts/steo/report/natgas.cfm>.

$58/year water/wastewater savings + $55/year natural gas savings = $113/year

Equation 24. Average Full Payback Period (Electricity Hot Water Heating)
($75/PRSV ÷ $189/year) x 12 months/year = 4.8 months

Equation 25. Average Full Payback Period (Natural Gas Water Heating)
($75/PRSV ÷ $113/year) x 12 months/year = 8.0 months