ESTIMATING THE ANNUAL WATER AND ENERGY SAVINGS IN TEXAS A&M UNIVERSITY CAFETERIAS USING LOW FLOW PRE-RINSE SPRAY VALVES

A Thesis

by

HARSH VARUN REBELLO

Submitted to the Office of Graduate Studies of
TexasA&MUniversity
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2010

Major Subject: Construction Management

Estimating the Annual Water and Energy Savings in Texas A&MUniversity Cafeterias

Using Low Flow Pre-Rinse Spray Valves

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Approved by:

Co-Chairs of Committee,	Jerry Jackson
	Joe Horlen
Committee Member,	Bryan Boulanger
Head of Department,	Joe Horlen

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ABSTRACT

Estimating the Annual Water and Energy Savings in Texas A&M University Cafeterias

Using LowFlow Pre-Rinse Spray Valves.(May 2010)

Harsh Varun Rebello, B. Arch., University of Mumbai

Co-Chair of Advisory Committee: Dr. Jerry Jackson
Dr. Joe Horlen

Improving the efficiency of a Pre- Rinse Spray Valve (PRSV) is one of the most cost effective water conservation methods in the Food Services Industry. A significant contributor to this cost efficiency is the reduction in the energy costs required to provide the mandatory hot water. This research paper estimates the potential quantity and dollar value of the water and energy that can be saved annually in Texas A&M University's dining services with the installation of low flow pre-rinse spray valves.

The data collection was obtained from four of Texas A&M University's Dining Services facilities. The annual savings were estimated by contrasting the water consumption of the existing T & S Brass B 0107-M PRSVs with the latest and most advanced available low flow T & S Brass B 0107-C PRSV. The annual water consumption of the existing and new PRSVs were predicted by measuring an individual average flow rate for each and observing the number of hours per day the PRSV would be used. The observed and measured values were extrapolated to amount rates to determine cost savings. The dollar value was ascertained using the utility cost data

recorded over a semester by the Facilities Coordinator of the Department of Dining Services.

The findings of this study show that the water savings from a single PRSV could lead to an estimated annual saving ranging between 46% and 78% of the current operation cost. The T & S Brass B 0107-C PRSV is currently priced between $52- $60 per valve resulting in a payback period ranging between 1.5-6 months per valve. If every valve on campus was replaced, the University could reap a savings in the range of $ 5,400-$22,590 over the 5 year useful life of the valve, having initially invested less than $550.

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NOMENCLATURE

CCF	Hundred cubic foot of water is a unit of measurement where 748 gallons makes 1 CCF or 100 cubic foot
Fixture	“The receptacles in plumbing or drainage systems, other than traps, intended to receive or discharge liquid or waste”. (Seo 2003)
Flow rate	A measure of the maximum amount of water that can flow through a fixture or piece of equipment per unit time
GPCD	A gallon per capita per day is an expression of the average rate of domestic and commercial water demand, usually computed for public water supply systems.
GPM	Gallons per minute, indicates the volume of liquid flowing through the fixture per unit time.
Kilowatt Hour (kWh)	This is an SI unit of heat energy and is the amount of energy expended (or dissipated) if work is done at a constant rate of one thousand watts for one hour

PSI	Pounds per square inch is a unit of pressure that results from the force of one pound-force applied to an area of one square inch.
Therms	A non SI unit of heat energy equal to 100,000 British thermal units (BTU).1 Therm is equal to 29.3 kWh
Temperature rise through Heater	The difference in the water temperature supplied to the water heater, and the water exiting the water heater. This is typically 70*F, which assumes a water line temperature of 75*F and a water heater setting of 145*F
Water Heater Efficiency	The percentage of energy delivered to the water divided by the amount of energy consumed by the water heater

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1. INTRODUCTION

1.1 Background

A survey published by the U.S. Government Accountability Office (GAO) in July 2003 found that under normal water conditions, water managers in 36 states anticipated water shortages in localities, regions, or statewide within the next 10 years. Under drought conditions 46 states could experience shortages in the next 10 years. The GAO report explains that such shortages could be accompanied by severe economic, environmental, and social impacts that would cause damages to varied segments of the economy. For example, in the summer of 1998, a drought that ranged from Texas to the Carolinas resulted in an estimated $6 to $9 billion in losses to the agriculture and ranching sectors [United States General Accounting Office 2003, GAO-03-514 p 5].

Consequently, in recent years water conservation programs have acquired great importance; giving rise to a number of studies that continually seek simple, cost-effective technologies that can be implemented quickly[Tso and Koeller 2005] to conserve water. However, water use varies in different sectors with the commercial, institutional, and industrial (CII or ICI) sector having the most diverse collection of water users in the urban environment.[1] Hence, there is a need for sector based studies to avoid having generalized conservation strategies cast over diverse uses. The university

This thesis follows the style of *Construction Management and Economics.*

[1]http://allianceforwaterefficiency.org/Commercial_Institutional_and_Industrial_Library_Content_Listing.aspx

cafeteria is one such unique area, which in the past has not received enough attention and requires separate studying. This facility is part of the commercial food service sector and represents one of the larger water using sectors in the non-residential category.[2] Furthermore, implementing this study at a university cafeteria spreads awareness about water conservation and gives students a practical education and provides a teaching opportunity on the merits of water conservation.[3]

1.2 Need for Research

Water use in a university cafeteria maybe divided into food preparation, dish (includes all utensils) washing and sanitation. Of these, dish washing offers a high potential for water savings. Installing low-flow pre-rinse spray valves (PRSV) in the dish room represents one of the easiest and most cost-effective methods of saving water in a commercial kitchen.

A PRSV is a handheld device comprising a spray nozzle, a squeeze lever that controls the water flow, and a dish guard bumper. PRSVs use hot water under pressure to clean food items off plates, flatware, and other kitchen items before they are placed into a commercial dishwasher. The valves are also used for purposes other than rinsing dishes, such as filling sinks, hosing down equipment, and even in food preparation [Energy Solutions, 2004].

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[2] http://allianceforwaterefficiency.org/Commercial_Food_Service_Introduction.aspx
[3] http://allianceforwaterefficiency.org/Schools_and_Universities.aspx

Since January 1, 2006, all new PRSVs sold have been low-flow, as required by the U.S. Energy Policy Act of 2005. Facilities using older, less-efficient spray valves, with typical flow rates of 4 to 6 gallons per minute (gpm), can realize considerable savings by switching to the new low-flow spray valves. [4]At Texas A&M University, 9 of the 11 existing PRSVs surveyed for this research were T & S Brass B 0107-M valves and had a rating of 1.42 gallons per minute at 60psi (Refer Figure 1).The other 2 valves didn't have any markings on them and while their specifications could not be identified their measured flow rates are similar to the T & S Brass B 0107-M. Thus the surveyed PRSVs all conformed to the norms specified by the EPA 2005.

However, as the manufacturer's specifications indicate, the flow rate of these low flow PRSVs is dependent on the supply water pressure. A variance in pressure renders the specifications inaccurate and the water consumption of these valves becomes uncertain. PRSVs generally have a performing lifespan of 5 years and become dysfunctional over extended use due to mineral build up. The condition of the existing valves indicated that they have reached or will soon reach their useful life and are in need of replacement. Furthermore, newer more efficient valves advertise flow rates that are approximately one half of the EPA requirements.

The objective of this research is to determine the potential water and cost savings benefits of replacing existing PRSVs with new more efficient PRSVs. Should these

[4] http://www.fesmag.com/article/ca6507133.html

Figure1: Existing PRSV: T & S Bras B-0107-M, 1.42 gpm at 60psi

valves be replaced with products with the same ratings at the end of their useful life or should the University invest in the latest available and more expensive technology? What benefits can investing in the latest PRSV provide the university and how cost effective will it be? Can these two factors justify a process of early replacement across the campus? These are the primary research questions this study aims to answer.

1.3 Research Intent

Consequently, this research intends to document the prevailing water pressure and establish the resultant flow rates of the existing PRSVs across a selected number of on-campus dining facilities. The intent of this research is to determine the potential water and energy savings that can be achieved if the existing spray valves in the dish room and/or kitchen are replaced with the latest available low-flow pre-rinse spray valves. This research will provide data that has previously not been collected for this sector and allows for the formulation of specific water conservation strategies.

1.4 Problem Statement

The purpose of this research is to determine the potential water and energy savings that can be achieved in the dish room and/or kitchen of a university cafeteria by replacing existing T & S Brass B 0107-Mspray valves with the latest available low-flow pre-rinse spray valve, the T & S Brass B 0107-C, with flow rate of 0.65gpm at 60psi. (Refer Figure 2 and Appendix A for details)

Figure2: Proposed PRSV: T & S Brass B 0107-C, 0.65 gpm at 60psi

1.5 Sub Problems

The research intends to address the following sub-problems:

1. Measure current equipment details in terms of flow rate of pre-rinse nozzles and pressure of water supply
2. Record operation hours per day of the PRSV
3. Record operating days per year of each facility studied
4. Document type of water heater and record the temperature rise through it

1.6 Hypothesis

The following hypothesis will be tested for the study:

> Replacing existing pre-rinse spray valves with the latest available low flow spray valves does not show a significant change in water and energy consumption in a university cafeteria.

1.7 Delimitations

Study has been delimited to the following constraints:

1. The study will be limited to only four cafeterias across the campus due to equipment availability and accessibility.
2. The flow rates of existing valves will be calculated with the valve handle completely squeezed (opened) and the hot and cold faucets fully opened so as to allow the maximum amount of water through.
3. The hours of operation per day have been estimated through observation of operators’ activities through a week.

4. The study will not include any measurements of water related activities on the floor of the cafeteria or public toilets associated with the cafeteria.

1.8 Site Selection

For the spring semester of 2010, the Texas A&M University offers fifteen “Campus Dining Options” run by the Department of Dining Services (Refer Figure 3). Six of these have dishwashing facilities that employ at least one PRSV. They are:

1. SBISA Dining Center (2PRSVs)
2. Underground Food Court (2PRSVs)
3. Pi R Square (1PRSVs)
4. Commons Food Court (2PRSVs)
5. Duncan Dining Center (3PRSVs)
6. 41st Club (1PRSVs)

The 41st Club has an atypical usage and was not considered for study. Similarly Pi R Square is a smaller facility than the other remaining facilities selected and was not included in the study. The Duncan facility had one leaking PRSV which was not considered in the study either. Thus the facilities selected were:

1. SBISA Dining Center (Operating 121 days in Spring 2010)
2. Underground Food Court (Operating 87 days in Spring 2010)
3. Commons Food Court (Operating 121 days in Spring 2010)
4. Duncan Dining Center (Operating 87 days in Spring 2010)

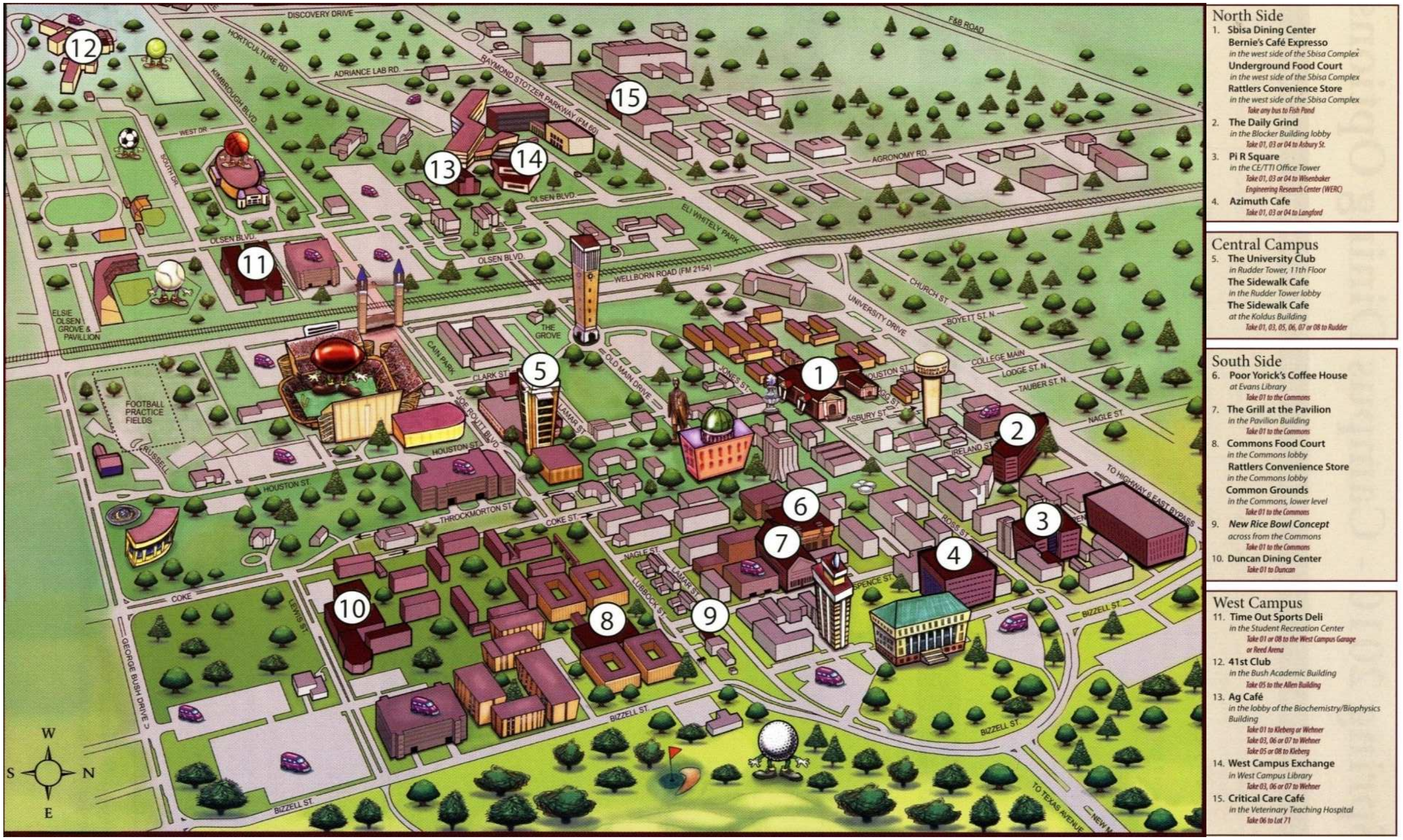

Figure 3: Spring 2010 Campus Dining Options, Source Texas A& M University, Department of Dining Services

2. LITERATURE REVIEW

The Alliance for Water Efficiency (AWE) (a non-profit organization dedicated to the efficient and sustainable use of water) states that in large restaurants and similar food service operations, dish washing typically consumes two-thirds of all water use of the facility. Furthermore, the water used in the pre-rinsing operation is often twice the volume of water used by the dishwashing equipment. The AWE believes that the most cost-effective water conservation measure in a commercial food service operation is the improving the efficiency of the pre-rinse spray valve (PRSV).[5] The efficiency of the PRSV can be measured by its flow rate as well as the washing effectiveness or "cleanability" which is the time in seconds to clean each dish.

The Food Service Technology Center (FSTC) in San Ramon, California was the first to conduct research on the resource saving potential of low flow PRSVs [Tso and Koeller 2005]. Through lab testing the FSTC established average flow rates for 21 different high efficiency valves. These ranged from 0.65gpm to 1.48gpm when tested at a supply pressure of 60 PSI. These values were not very different from their respective ratings except those rated at 80 PSI. They also established the "cleanability" per plate in seconds for each valve. When compared to the "cleanability" of the older PRSVs there was a difference of only a few seconds per plate. This showed that high efficiency PRSVs consumed less water to clean the same number of dishes in approximately the same time.

[5] http://allianceforwaterefficiency.org/commercial_dishwash_intro.aspx

From this study they developed a test method, now ASTM Standard F2324-03(2009), which specifies how to establish water consumption and cleaning performance of a low flow PRSV.

The findings of this study became part of a larger study; the California Urban Water Conservation Council (CUWCC) Pre-Rinse Spray Head Distribution Program or the Rinse and Save program. The primary focus of the program was to determine the energy savings realized from using low flow PRSV. The state of California was estimated to have approximately 102,000 hot water using PRSVs. The program offered to replace these facilities' old PRSVs with new high efficiency PRSVs free of cost. In doing so the hot water consumption of the participating facility was expected to be reduced, thereby saving energy by reducing the gas and electric energy required to heat hot water. The program has had three phases so far. In 2002, Phase 1 aimed to achieve gas savings of 7.39 million therms/year by installing 16,903 spray heads across California. Similarly, in 2005 Phase 2 aimed to achieve a gas savings of 8.27 million therms/year by installing 24,700 spray heads. Phase 3 was started in 2006.

The research methodology adopted the use of surveys as well as engineering data collected from 19 randomly selected sites (for phase 1). The surveys obtained building characteristics data and determined whether the new spray heads were still in service, thus screening sites for short-term metering of spray head hot water use. Engineering data involved metering pre and post- installation hot water usage for at least one month as well as water pressure, cold/mixed/hot water temperatures, and flow rate measurements on site. The metered hot water usage provided a basis for estimating the actual mixed water usage per valve per day at each site [Tso and Koeller 2005]. The engineering data was used to develop estimates of average energy savings per spray head across the program.

To calculate unit energy savings, electric and gas domestic water heating system efficiencies were considered as 90% and 70%, respectively as provided by the Food Service Technology Center. Also, the average annual water supply temperatures were determined from water agency information. The following key equations were used to for calculating pre- and post-installation energy and water usage [SBW Report No. 0605, 2007]:

- ***Daily mixed water use*** *(gallons/day/head) = Metered mixed water usage (gallons) ÷ elapsed metering time (days)*
- ***Annual mixed water use*** *(gallons/year/head) = Daily mixed water use (gallons/day) * equivalent annual operating days (days/year)*
- ***Daily hours of use*** *(hours/day/head) = [Daily mixed water use (gal/day)] / [(60 minutes/hour) × (Spray head flow rate (gal/min))]*
- ***Annual energy use*** *(therms/year/head) = Annual Mixed water use * [Mixed Water temperature (°F) – Cold Water temperature (°F)] * Density (8.33 lb/gal) ÷ Domestic hot water efficiency ÷ 100000*

- ***Annual energy use*** *(kWh/year/head) = Annual Mixed water use * [Mixed Water temperature (°F) – Cold Water temperature (°F)] * Density (8.33 lb/gal) ÷ Domestic hot water efficiency ÷3413*
- ***Total Annual energy savings*** *= [Pre annual energy use (therms/year/head) – Post annual energy use (therms/year/head)] * # of Heads claimed by program * % Spray head retention rate * % Spray heads claimed that were verified installed*
- ***Annual water savings*** *(gallons/year) = [Pre annual mixed water use – Post annual mixed water use] * # of Heads claimed by program * % Spray head retention rate * % Spray heads claimed that were verified installed*

Results from phase 1 indicated the overall energy savings per spray head were 20.9 kWh/day/head for electric heating and 0.92 therms/day/head for gas heating. These energy cost savings were calculated using the average spray head flow reduction of 2.24 gallons/minute determined from the 19 metered sites. Furthermore, the Phase 1 study found gas savings of 5.58 million therms/year which was 68% of the initial target set [SBW Consulting, Inc. Report No. 0401, 2004].

Following the direct-installation model of the CUWWC a number of locations across America have undertaken similar studies and yielded significant energy and water savings (refer Table 1). In Canada the Region of Waterloo and City of Calgary also conducted pilot studies in 2004-2005 similar to the CUWWC Rinse and Save program. The data collected at ten sites for each study included the flow rate of existing fixtures, the flow rate of replacement fixture, the supply pressures and finally the duration of use. Through the course of the pilot study in the Region of Waterloo, researchers became aware of the effects of extreme pressure on the performance of the PRSV [Gauley 2005b].

Table 1: Direct Install Spray Head Programs. Source: Tso and Koeller 2005

Program Sponsor	Geographic Coverage	Number of Valves installed
California Urban Water Conservation Council	State of California	41,000 through Phase 2
Puget Sound Energy (Washington State)	Counties of King, Snohomish, Thurston& Pierce	7,750
City of Austin (Texas)	Austin	900
Pinellas County Utilities (Florida)	Pinellas County	3,000 (through 2010)
City of St. Petersburg (Florida)	St. Petersburg	1,350
Hillsborough County (Florida)	Hillsborough County	1,000

When the pressure was too high (in excess of 85 PSI) Food Service Employees (FSEs) complained of excessive spraying and splashing. On the other extreme when the pressure was too low (below 60 PSI) FSEs complained that the high efficiency valves were incapable of washing certain utensils. This problem was avoided in the City of Calgary study by pre-qualification of sites with nominal pressures.

The findings of the Waterloo study showed that a water savings of 245 liters per valve per day could be achieved using high efficiency PRSVs. This value was found to be three times greater than the savings expected from toilet replacement programs in the region. On calculating the savings that could be achieved through a region wide program, the study determined it was possible to save $317m^3$ of water per day. This was found to meet the needs of 1,268 persons at a per capita demand rate of 250 liters of water per person per day for this region [Gauley 2005b].

The calculated energy savings were based on values provided in the Rinse and Save report summary. No specific site data regarding energy savings was gathered as part of the Waterloo project. The study found a savings of 0.35 therms per valve per day for gas heaters and 4.8kWh per valve per day for electric heaters. Combining the water and energy savings, researchers estimated a total average projected customer saving of $1,500 (Canadian dollars) per valve over its 5 year life [Gauley2005b]. Considering the $60 (Canadian dollars) cost of the valve, this replacement measure proves an extremely cost effective water conservation option (payback period of less than 3 months).

The findings for the City of Calgary study showed a water savings of 358 liters per valve per day. The total average projected customer savings, including the energy savings over the valve's 5 year life, ranged from $1,400 (Canadian dollars) for gas heaters and $1,800 (Canadian dollars) for electric heaters per valve [Gauley 2005a].

SBW Consulting, Inc, the firm that undertook the evaluation, measurement and verification studies for the CUWWC program, summarized the various savings achieved in studies thus far (refer table 2). “For the 36 metered food service establishments with Fisher 1.6-gpm valves, the average annual water/sewer savings are 50 CCF/year (more than 37,000 gallons annually). Corresponding natural gas savings are 194 therms/year. Savings for the seven metered grocery installations were quite small, at 1.3 CCF/year (968 gallons) and 5.8 therms/year. Savings per site vary significantly, with cases of water savings as high as 220 CCF/year and as low as –12 CCF/year” [Tso and Koeller 2005].

The firm also stated that there has been no metering done for certain sectors such as schools and institutions. They believe that further study is needed to assess the actual usage and savings in such significant sectors [Tso and Koeller 2005].

Table 2: Annual Utility Savings per Valve. Source: Tso and Koeller 2005

Facility Type/ location/ program	Count	Water/ sewer (CCF)	Water/ sewer (gal)	Natural gas (therms)	Cost saving[1]	Cost savings range ($)*
Food Service						
California (CUWCC Phase 1)	18	69.7	52,157	252	550	291-860
California (CUWCC Phase 2)	8	38.5	28, 778	167	326	177-508
Washington (Starbucks)	5	12.0	8,986	43	94	50-147
Region of Waterloo, Canada	5	35.7	26,669	178	320	178-498
Washington (SPU pretest)**	4	40.2	30,069	116	293	150-460
SUBTOTAL**	**36**	**50.0**	**37,425**	**194**	**405**	**216-633**
Grocery						
California (CUWCC Phase 2)	6	1.2	917	5.4	10	6 - 16
Region of Waterloo, Canada	1	1.7	1,277	8.5	15	9 - 24
SUBTOTAL	**7**	**1.3**	**968**	**5.8**	**11**	**6 - 17**

[1]Dollar value at medium utility rates

* Utility rate assumptions:	Water/ Sewer ($/CCF)	Gas ($/therm)
Medium	5.00	0.80
High	8.00	1.20
Low	2.00	0.60

** The Seattle Public Utilities pretest used 2.2-gpm valves, and thus is not included in the subtotal.

3. DATA COLLECTION

3.1 Research Methodology

Water and energy savings using low flow valves were determined using FSTC's "Pre Rinse Spray Valve/ Water Cost Calculator". This calculator is available at (refer Figure 4):http://www.fishnick.com/savewater/tools/watercalculator/

The primary data required for the calculations are the average flow rate of the existing PRSVs and its hours of operation per day as well as the average flow rate of the new PRSV. When obtaining the flow rate it was necessary to check the supply pressure as this needs to be constant when determining the flow rate of the new PRSV. This was measured and recorded using a pressure gauge. A consistent fluctuation of about 5psi was noted.

Determining the average flow rate of the existing PRSVs was carried out by measuring the volume of water flowing from the PSRV in one minute. This was done using a large bucket and a weighing scale. The procedure involves two steps. Initially the empty bucket is weighed and the empty weight is recorded. Then the spray valve is held over the bucket with the handle squeezed to maximum flow and elapsed time is recorded with a stopwatch. At the end of one minute the filled container is then weighed; subtracting the weight of container leaves the weight of water (one gallon weighs 8.34lbs). From this the exact volume of water is determined. On a single day, this procedure was carried

User Inputs			
Spray Valve Performance and Use			
New Device Water Flow Rate	0.8	Gal/m	[Default] [Help]
Old Device Water Flow Rate (Optional)	3.1	Gal/m	[Default] [Help]
Operating Hours per Day	0.8	h/d	[Default] [Help]
Operating Days per Year	270	d/y	[Default] [Help]
Water Heating Performance and Costs			
Water Heater Fuel Type	(•) Electric ( ) Gas		
Water Heater Efficiency	95.0	%	[Default] [Help]
Temperature Rise Through Heater	70	°F	[Default] [Help]
Electric Cost per kWh	0.13	$/kWh	[Default] [Help]
Water Cost per CCF (100 cubic feet)	2.00	$/CCF	[Default] [Help]
Sewer Cost per CCF (100 cubic feet)	3.00	$/CCF	[Default] [Help]
	Calculate		[Default All]

Results		
	New Device Results [Assumptions]	Old Device Results [Assumptions]
Annual Water Consumption (Gallons)	10368	40176
Annual Water Consumption (Units)	13.9	53.7
Annual Water Heating Energy (kWh)	1865	7225
Annual Water Cost	$ 27.80	$ 107.40
Annual Sewer Cost	$ 41.70	$ 161.10
Combined Annual Water and Sewer Cost	$ 69.50	$ 268.50
Annual Water Heating Cost	$ 242.39	$ 939.28
Overall Annual Cost	$ 311.89	$ 1207.78
Optional: Name for Printed Results:		
Click to Print Results		

Figure 4: Pre- Rinse Spray Valve Water Cost Calculator

Source: http://www.fishnick.com/savewater/tools/watercalculator/

out three times per valve to provide the average flow rate. The valve was tested again later in the month to ensure a constant supply pressure. The tests confirmed a consistent supply pressure within each facility, hence to measure the flow rate of the new valve only one of the existing valves was retrofitted at each facility.

The average hours of operation were initially determined by observing the various operators' shifts for a period of one week per facility. However in this process it was realized that the operators don't use the valves for the entire time that they are working at their respective station. So recording their shift timing was not an accurate documentation of the time that the valve is used. Thus the duration of every instance that the valve was actually used was estimated on the basis of these and further observations per facility.

The operating days per year were determined from the Texas A&M Dining Service's calendar. However, only the Spring and Fall semesters were considered as the Summer semester caters to lesser number of students. This would affect the estimated daily hours of operation if considered. This spring the Dining Services operate from January 14^{th} to May 14^{th} 2010. SBISA and the Commons Food Court operate all 7 days of the week; 121 days, whereas the Duncan Dining Center and the Underground Food Court operated 5 days a week; 87 days. Thus through the year, it is assumed that the Spring and Fall Semester are of the same duration, these facilities operated 242 days and 174 days respectively.

Finally, the dollar value of these savings was determined using utility cost data recorded over the Fall 2009 Semester, by the Facilities Coordinator of the Department of Dining Services. The annual cost for the utilities was developed through an average of the Fall semester's rates. There is sure to be a rise in prices; however this annual cost reflects the minimum savings that can be realized in the Spring and Fall 2010 semesters. From the cost data the water heater fuel type was determined to be a gas type as the unit of measurement was in MBTU (1000 British Thermal Units).

3.2 Variables and Units of Measurement

1. Dependent Variable:
    a. Volume of water consumed by existing PRSVs cubic feet of water (CCF)
2. Independent Variables:

a.	flow rate of existing PRSVs	gallons/ minute
b.	operating hours of the PRSV	hours/day
c.	Hours of operation of facility	days/year
d.	Temperature rise through water heater	degrees Fahrenheit

The collection of the above mentioned variables was carried out at four facilities on the Texas A&M University Campus. The measurement for the average flow rate of the various spray valves was carried out twice at each facility to ensure pressure variations did not exist. (Refer Tables 3- 24)

3.3 Flow Rates at Duncan Dining Center

Facility Information:

Operating hours per Day:	2.5hrs
Operating Days per Year:	174 days
Water Heater Fuel Type:	Gas
Water Pressure:	75psi (+/-5)
Number of PRSVs:	3

Testing Information:

Weight of empty bucket:	2.25lbs
Weight of 1 gallon of water:	8.34lbs
Timer Interval:	1 minute

Table 3: Average Flow Rate on 02.06.2010 for PRSV 1 at Duncan

PRSV No.1

Location: Kitchen: (Outside Executive Chef's office)
Type: T & S Brass 1.42gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	33.60	31.35	3.76
2*	33.60	31.35	3.76
3	33.60	31.35	3.76
4	33.60	31.35	3.76
		Average Flow rate:	3.76

* Reading 2 was taken after letting the bucket stand for 5 minutes. This was done to insure there was no loss of water due to leakages in the bucket

Table 4: Average Flow Rate on 02.06.2010 for PRSV 2 at Duncan

PRSV No.2

Location: Kitchen: (Opposite PRSV No. 1)
Type: T & S Brass 1.42gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	6.20	3.95	0.47
2	6.20	3.95	0.47
3	6.20	3.95	0.47
		Average Flow rate:	0.47

This device leaked when turned on; hence there must have been a considerable loss before the water reached the nozzle. This reading was discarded.

Table 5: Average Flow Rate on 02.06.2010 for PRSV 3 at Duncan

PRSV No.3

Location: Dish room (Near Dishwasher)
Type: T & S Brass 1.42gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	29.20	26.95	3.23
2	29.20	26.95	3.23
3	29.20	26.95	3.23
		Average Flow rate:	3.23

Table 6: Average Flow Rate on 02.15.2010 for PRSV 1 at Duncan

PRSV No.1

Location: Kitchen: (Outside Executive Chef's office)
Type: T & S Brass 1.42gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	33.75	31.50	3.78
2	33.75	31.50	3.78
3	33.70	31.45	3.77
		Average Flow rate:	3.78

Table 7: Average Flow Rate on 02.15.2010 for PRSV 3 at Duncan

PRSV No.3

Location: Dish room (Near Dishwasher)
Type: T & S Brass 1.42gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	29.30	27.05	3.24
2	29.30	27.05	3.24
3	29.35	27.10	3.25
		Average Flow rate:	3.24

3.4 Flow Rates at Commons Food Court

Facility Information:

Operating hours per Day:	2.5hrs
Operating Days per Year:	242 days
Water Heater Fuel Type:	Gas
Water Pressure:	85psi (+/-5)
Number of PRSVs:	2

Testing Information:

Weight of empty bucket:	2.25lbs
Weight of 1 gallon of water:	8.34lbs
Timer Interval:	1 minute

Table 8: Average Flow Rate on 02.06.2010 for PRSV 1 at Commons

PRSV No.1

Location: Kitchen: (Near Office)
Type: unknown

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	38.65	36.40	4.36
2	38.65	36.40	4.36
3	39.35	37.10	4.45
		Average Flow rate:	4.39

Table 9: Average Flow Rate on 02.06.2010 for PRSV 2 at Commons

PRSV No.2

Location: Dish room
Type: T & S Brass 1.42gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	12.85	10.60	1.27
2	12.65	10.40	1.25
3	12.80	10.55	1.26
		Average Flow rate:	1.26

Table 10: Average Flow Rate on 02.15.2010 for PRSV 1 at Commons

PRSV No.1

Location: Kitchen (near office)
Type: Unknown

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	38.80	36.55	4.38
2	39.35	37.10	4.44
3	39.35	37.10	4.44
		Average Flow rate:	4.43

Table 11: Average Flow Rate on 02.15.2010 for PRSV 2 at Commons

PRSV No.2

Location: Dish room
Type: T & S Brass 1.42gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	12.65	10.40	1.25
2	12.65	10.40	1.25
3	12.75	10.50	1.26
		Average Flow rate:	1.25

3.5 Flow Rates at SBISA Dining Center

Facility Information:

Operating hours per Day: 2.5hrs
Operating Days per Year: 242 days
Water Heater Fuel Type: Gas
Water Pressure: 70psi (+/-5)
Number of PRSVs: 2

Testing Information:

Weight of empty bucket: 2.25lbs
Weight of 1 gallon of water: 8.34lbs
Timer Interval: 1 minute

Table 12: Average Flow Rate on 02.017.2010 for PRSV 1 at SBISA

PRSV No.1

Location: Kitchen: (Near Grills)
Type: T&S Brass 1.42 gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	29.60	27.35	3.28
2	29.20	26.95	3.23
3	29.95	27.70	3.32
		Average Flow rate:	3.28

Table 13: Average Flow Rate on 02.17.2010 for PRSV 2 at SBISA

PRSV No.2

Location: Kitchen: (Near Service Elevator)
Type: T & S Brass 1.42gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	28.35	26.10	3.13
2	29.00	26.75	3.21
3	29.00	26.75	3.21
		Average Flow rate:	3.18

Table 14: Average Flow Rate on 02.19.2010 for PRSV 1 at SBISA

PRSV No.1

Location: Kitchen (near grills)
Type: T & S Brass 1.42gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	29.25	27.00	3.24
3	29.25	27.00	3.24
4	29.35	27.10	3.25
		Average Flow rate:	3.24

Table 15: Average Flow Rate on 02.19.2010 for PRSV 2 at SBISA

PRSV No.2

Location: Kitchen: (Near Service Elevator)
Type: T & S Brass 1.42gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	28.10	25.85	3.10
3	28.10	25.85	3.10
4	28.10	25.85	3.10
		Average Flow rate:	3.10

3.6 Flow Rates at Underground Food Court

Facility Information:

Operating hours per Day:	2.5hrs
Operating Days per Year:	174 days
Water Heater Fuel Type:	Gas
Water Pressure:	70psi (+/-5)
Number of PRSVs:	2

Testing Information:

Weight of empty bucket:	2.25lbs
Weight of 1 gallon of water:	8.34lbs
Timer Interval:	1 minute

Table 16: Average Flow Rate on 02.17.2010 for PRSV 1 at Underground

PRSV No.1

Location: Dish room: (Near dishwasher)
Type: T & S Brass 1.42gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	14.35	12.10	1.45
3	14.35	12.10	1.45
4	14.80	12.55	1.50
		Average Flow rate:	1.47

Table 17: Average Flow Rate on 02.17.2010 for PRSV 2 at Underground

PRSV No.2

Location: Dish room (at dishwasher)
Type: T & S Brass 1.42gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	14.80	12.55	1.50
2	14.80	12.55	1.50
3	14.80	12.55	1.50
		Average Flow rate:	1.50

Table 18: Average Flow Rate on 02.19.2010 for PRSV 1 at Underground

PRSV No.1

Location: Dish room (near dishwasher)
Type: T & S Brass 1.42gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	14.75	12.50	1.50
2	14.75	12.50	1.50
3	14.70	12.45	1.49
		Average Flow rate:	1.50

Table 19: Average Flow Rate on 02.19.2010 for PRSV 2 at Underground

PRSV No.2

Location: Dish room (at dishwasher)
Type: T & S Brass 1.42gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	15.40	13.15	1.58
2	15.40	13.15	1.58
3	15.45	13.20	1.58
		Average Flow rate:	1.58

3.7 Summary of Readings for Existing PRSV Average Flow Rates

The table below provides the average flow rate for each of the valves at the four facilities taken on 2 separate days (refer Table 20).

Table 20: Summary of all Average Flow Rates Across the Four Facilities

Facility	PRSV 1		PRSV 2	
	02.06.10	02.15.10	02.06.10	02.15.10
Duncan Dining Center	3.76 gpm	3.78gpm	3.23gpm	3.24 gpm
Commons Food Court	4.39 gpm	4.43gpm	1.26gpm	1.25 gpm
	02.17.10	02.19.10	02.17.10	02.19.10
SBISA Dining Center	3.28 gpm	3.24 gpm	3.18 gpm	3.10 gpm
Underground Food Court	1.47 gpm	1.50 gpm	1.50 gpm	1.58 gpm

As mentioned previously, though the supply pressure varied at each facility it remained constant within the facility. Hence to ascertain the flow rate of the new valves only one valve at each facility was retrofitted. For the purpose of contrasting the existing spray valve (ePRSV) in each facility with the new one (nPRSV), an average of the two readings was taken. The list of ePRSVs below represents the lower flow rates at each facility so as to attain the minimum potential savings.

Facility	ePRSV Flow rate
1. Duncan Dining Center:	3.24 gpm
2. Commons Food Court:	1.26 gpm
3. SBISA Dining Center:	3.26 gpm
4. Underground Food Court:	1.54 gpm

3.8 Flow Rate of New PRSV at Duncan Dinning Center

The new low- flow PRSV nozzle, T & S Brass B 0107-C, was tested on PRSV assembly in the dish room of the Duncan Dining Center, replacing the existing nozzle. The same test to establish the flow rate was carried out with this nozzle (Refer table 21).

Table 21: Average Flow Rate on 02.26.2010 for New PRSV at Duncan

PRSV No.1

Location: Dish room (near dishwasher)
Type: T & S Brass B0107-C 0.65gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	8.10	5.85	0.70
2	8.10	5.85	0.70
3	8.10	5.85	0.70
		Average Flow rate:	0.70

3.9 Flow Rate of New PRSV at Commons Food Court

The new low- flow PRSV nozzle, T & S Brass B 0107-C, was tested on PRSV assembly in the dish room of the Commons Food Court, replacing the existing nozzle. The same test to establish the flow rate was carried out with this nozzle (Refer table 22).

Table 22: Average Flow Rate on 02.26.2010 for New PRSV at Commons

PRSV No.1

Location: Dish room (near dishwasher)
Type: T & S Brass B0107-C 0.65gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	8.25	6.00	0.72
2	8.25	6.00	0.72
3	8.25	6.00	0.72
		Average Flow rate:	0.72

3.10 Flow Rate of New PRSV at SBISA Dining Center

The new low- flow PRSV nozzle, T & S Brass B 0107-C, was tested on PRSV assembly in the dish room of the SBISA Dining Center, replacing the existing nozzle. The same test to establish the flow rate was carried out with this nozzle (Refer table 23).

Table 23: Average Flow Rate on 02.26.2010 for New PRSV at SBISA

PRSV No.1

Location: Dish room (near dishwasher)
Type: T & S Brass B0107-C 0.65gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	10.10	7.85	0.94
2	10.10	7.85	0.94
3	10.10	7.85	0.94
		Average Flow rate:	0.94

3.11 Flow Rate of New PRSV at the Underground Food Court

The new low- flow PRSV nozzle, T & S Brass B 0107-C, was tested on PRSV assembly in the dish room of the Underground Food Court, replacing the existing nozzle. The same test to establish the flow rate was carried out with this nozzle (Refer table 24).

Table 24: Average Flow Rate on 02.26.2010 for New PRSV at Underground

PRSV No.1

Location: Dish room (near dishwasher)
Type: T & S Brass B0107-C 0.65gpm

Reading No.	Weight of Water + Bucket (lbs)	Weight of Water (lbs)	Flow rate (gpm)
1	8.10	5.85	0.70
2	8.10	5.85	0.70
3	8.10	5.85	0.70
		Average Flow rate:	0.70

3.12 Estimated Annual Utilities Unit Cost Data

Water Heater Efficiency:	80%
Temperature Rise Through Heater:	70*F
Gas Cost per Therm:	$0.18
Water Cost per CCF:	$1.12
Waste Water Treatment Cost per CCF:	$2.21

The cost of these utilities is an average annual cost estimated by tracking these cost over a period of a semester at Texas A&M University. This data was obtained from Mr. Ernest Box, the Facilities Coordinator of the Department of Dining Services.

4. ESTIMATING SAVINGS FROM DATA COLLECTED

4.1Savings Estimated at Duncan Dining Center

The annual utility consumption and costs at the Duncan Dining Center (Refer Table 25) were calculated using FSTC's "Pre Rinse Spray Valve/ Water Cost Calculator" (Detailed in section 3.1) and the average annual utilities unit costs (Detailed in section 3.12).

Table 25: Savings Estimated at Duncan

Description	ePRSV	nPRSV	Savings
Average Flow Rate (gpm)	3.24	0.70	
Daily Water Consumption (Gallons)	480	105	375
Annual Water Consumption (Gallons)	83,520	18, 270	65,250
Annual Water Consumption (CCF)	111.7	24.4	87.3
Annual Water Heating Energy (Therms)	609	133	476
Annual Water Cost	$125.10	$27.33	$97.77
Annual Water Heating Cost	$109.58	$23.97	$85.61
Annual Waste Water Treatment Cost	$246.86	$53.92	$192.94
Overall Annual Cost	$481.54	$105.22	$376.32

4.2 Savings Estimated at Commons Food Court

The annual utility consumption and costs at the Commons Food Court (Refer Table 26) were calculated using FSTC's "Pre Rinse Spray Valve/ Water Cost Calculator" (Detailed in section 3.1) and the average annual utilities unit costs (Detailed in section 3.12).

Table 26: Savings Estimated at Commons

Description	ePRSV	nPRSV	Savings
Average Flow Rate (gpm)	1.26	0.72	
Daily Water Consumption (Gallons)	195	105	90
Annual Water Consumption (Gallons)	47,190	25,410	21,780
Annual Water Consumption (CCF)	63.1	34.0	29.1
Annual Water Heating Energy (Therms)	344	185	159
Annual Water Cost	$70.67	$38.08	$32.59
Annual Water Heating Cost	$61.91	$33.34	$28.57
Annual Waste Water Treatment Cost	$139.45	$75.14	$64.31
Overall Annual Cost	$272.03	$146.56	$125.47

4.3 Savings Estimated at SBISA Dining Center

The annual utility consumption and costs at the SBISA Center (Refer Table 27) were calculated using FSTC's "Pre Rinse Spray Valve/ Water Cost Calculator" (Detailed in section 3.1) and the average annual utilities unit costs (Detailed in section 3.12).

Table 27: Savings Estimated at SBISA

Description	ePRSV	nPRSV	Savings
Average Flow Rate (gpm)	3.26	0.94	
Daily Water Consumption (Gallons)	495	135	360
Annual Water Consumption (Gallons)	119,790	32,670	87,120
Annual Water Consumption (CCF)	160.1	43.7	116.4
Annual Water Heating Energy (Therms)	873	238	635
Annual Water Cost	$179.31	$48.94	$130.37
Annual Water Heating Cost	$157.16	$42.86	$114.3
Annual Waste Water Treatment Cost	$353.82	$96.58	$257.24
Overall Annual Cost	$690.29	$188.38	$501.91

4.4 Savings Estimated at Underground Food Court

The annual utility consumption and costs at the Underground Food Court (Refer Table 28) were calculated using FSTC's "Pre Rinse Spray Valve/ Water Cost Calculator" (Detailed in section 3.1) and the average annual utilities unit costs (Detailed in section 3.12).

Table28: Savings Estimated at Underground

Description	**ePRSV**	**nPRSV**	**Savings**
Average Flow Rate (gpm)	1.50	0.70	
Daily Water Consumption (Gallons)	405	105	120
Annual Water Consumption (Gallons)	39,150	18,270	20,880
Annual Water Consumption (CCF)	52.3	24.4	27.9
Annual Water Heating Energy (Therms)	285	133	152
Annual Water Cost	$58.58	$27.33	$31.25
Annual Water Heating Cost	$51.36	$23.97	$27.39
Annual Waste Water Treatment Cost	$115.48	$53.92	$61.56
Overall Annual Cost	$225.52	$105.22	$120.20

4.5 Evaluation of Savings

The findings of this study show that the water savings from a single PRSV per day range between 90–375 gallons. Considering the University has 9 PRSVs in operation this could lead to a daily savings ranging between 810–3,375gallons; this can meet the needs of between 6 to 25 persons in College Station at a per capita demand rate of 135 gallons per person per day.

On an annual basis the dollar value of these savings per PRSV range between $120.20 - $501.91. These savings consist of a 26% saving in water cost, 23% savings in electrical cost and 51% savings in waste water treatment cost. Thus replacing a single PRSV could bring about an annual saving ranging between 46% and 78% of its current operation cost. Again considering 9PRSVs across the University, the savings could range from $1,080- $4,518 per PRSV. The T & S Brass B 0107-C PRSV is currently priced between $52- $60 per valve. Replacement of the existing valves provides a payback period ranging between 1.5-6 months per valve, thus making this an extremely cost effective water conservation method.

As mentioned earlier the PRSVs examined for this study have a useful life of 5 years, hence if each valve was replaced, the University could reap a savings in the range of $5,400- $22,590 over 5 years having initially invested less than $550. It is thus expected that the Facility Coordinator of the Dining Services, will see the opportunity to achieve cost-effective savings and begin implementing a similar type of pre-rinse spray valve replacement program on the Texas A&M campus.

5. CONCLUSION

5.1 Summary

The study aimed to understand the effect of a varying supply pressure on the flow rate of the existing PRSV. From the study it is evident that a higher supply pressure considerably increases the flow rate of the PRSV. As a result the manufacturer's rating of the flow rate becomes inaccurate and the amount of water the PRSV consumed on a daily as well as annual basis was uncertain. This research thesis thus determined the savings that could be achieved, under prevailing pressure, by replacing the existing PRSVs with the latest most advanced PRSV in the market. The study estimated the cost effectiveness of valve replacement. The minimum financial savings over the useful life of the valve were estimated at $5,400. Results show a variation in savings resulting from observed variations in water flow across the four facilities indicating a maximum savings as large as $22,590. Furthermore, the maximum payback period of 6 months make a strong case for early replacement of out of date PRSVs as this can be factored into the annual operations expense budget of the dining services department and does not require a separate capital improvement plan.

5.2 Significance of the Research

For the state of Texas, appeals for water conservation may seem unnecessary as it doesn't experience as drastic a water shortage problem that particular parts of the country do. However, for any University, economically speaking water conservation is a wise step that could save many related running costs in a building. For a Facility

Manager trying to budget University expenses for operations and maintenance this research could provide the necessary information to do so. Previous research, in the field of water conservation has inferred that practicing water conservation on a consistent basis can delay and even obviate a buildings need for new water supply infrastructure. Reducing the demand of utilities can frequently extend the life of existing infrastructure, saving consumers the cost of building or renovating (Seo 2003). Furthermore, as the cost of energy continues to rise, the cost to supply, treat, and to dispose of water will increase, causing the need for formulation of specific water conservation strategies. The purpose of this study is to provide information that will facilitate the devising of these strategies.

5.3 Recommendations for Future Research

From this research it is evident that improving the efficiency of a plumbing fixture can significantly reduce operation costs of a facility. A similar study needs to be carried out to gauge the conservation potential as well as cost effectiveness of retro-fitting every faucet across the Texas A&M Campus with the latest, most advanced faucet aerator available in the market. It would be interesting to contrast the savings and cost effectiveness per unit of this program as well as the PRSV program with a series of other water conservation programs such as low flow toilets. The Waterloo study found that the savings per PRSV were three times the saving achieved from low flow toilet replacement programs in the area. Similarly, retrofitting the T & S Brass B- 0107 C PRSV requires bare minimum plumbing resources, if any, as compared to replacing a toilet, thus saving additional indirect costs. Such cost information could greatly aid a

Facility Manager's decision in prioritizing investments towards the goal of reducing future cost of operations.

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APPENDIX A

FOOD SERVICE TECHNOLOGY CENTER
PROMOTING ENERGY EFFICIENCY IN FOODSERVICE

1.800.398.3782 12949 Alcosta Blvd Suite 101 San Ramon CA 94583

Pre Rinse Spray Nozzle Test Summary Report **FSTC Report #: 5012.09.22** **Date: 07.02.09**

Specifications	
Make	T&S Brass
Model	B-0107-C & EB-0107-C
Rated Flow Rate @ 60 psi (gpm)	0.65

Test Parameters	
Water Pressure	60 ± 2 psi
Water Temperature	120 ± 4°F

Nozzle #1 - Solid Position

Test	Flow Rate (gpm)	Cleanability (seconds)
1	0.65	21
2	0.65	21
3	0.64	21
Average	0.65	21

Nozzle #2 - Solid Position

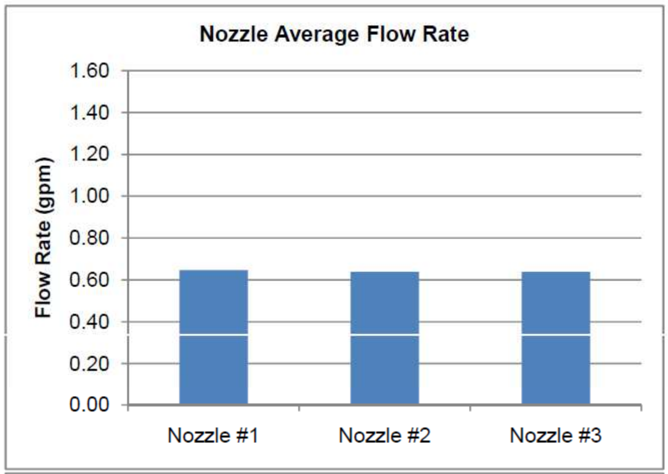
Test	Flow Rate (gpm)	Cleanability (seconds)
1	0.64	21
2	0.64	22
3	0.64	22
Average	0.64	21

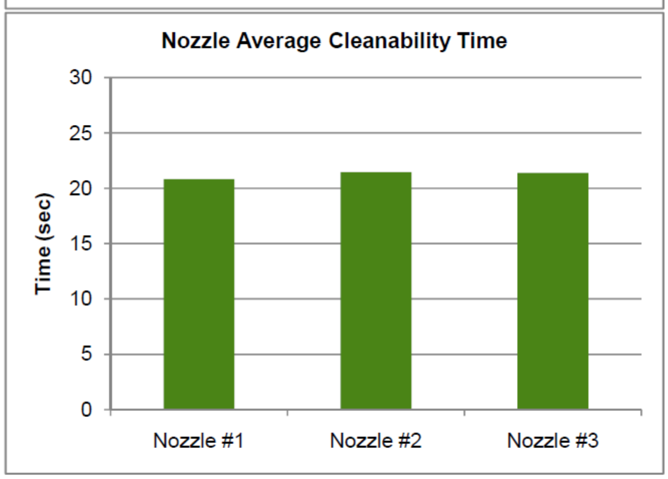
Nozzle # 3 - Solid Position

Test	Flow Rate (gpm)	Cleanability (seconds)
1	0.64	21
2	0.64	21
3	0.64	21
Average	0.64	21

Average Results

	Water Flow (gpm)	Cleanability (seconds)
Nozzle #1	0.65	21
Nozzle #2	0.64	21
Nozzle #3	0.64	21
Average	**0.64**	**21**





- Tested in accordance with ASTM F2324 - 03 (Standard Test Method for Prerinse Spray Valves)
- Tested nozzles are in compliance with the minimum performance provisions shown in section 1605.3(h) of CA Title 20 Appliance Efficiency Regulation
- Tested nozzles are in compliance with the appropriate marking requirements shown in section 1607 of CA Title 20 Appliance Efficiency Regulation

- The Food Servi ce Technology Center program is funnded by the California utility customer and administered by the Pacific Gas & Electric Company under the auspices of the California Public Utilities Commission

T&S BRASS AND BRONZE WORKS, INC.
2 Saddleback Cove / P.O. Box 1088
Travelers Rest, SC 29690

REG. #A2601
ISO #9001

Travelers Rest, SC: 800-476-4103 Simi Valley, CA: 800-423-0150 Fax: 864-834-3518 www.tsbrass.com

Model No.
B-0107-C

Item No.

This Space for Architect/Engineer Approval

Job Name________________________Date_________

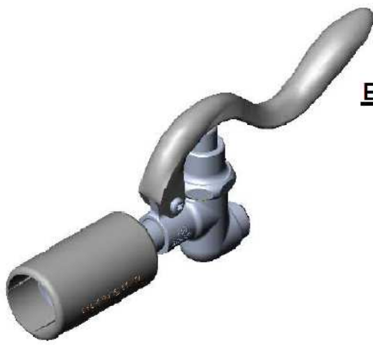
Model Specified____________________ Quantity______

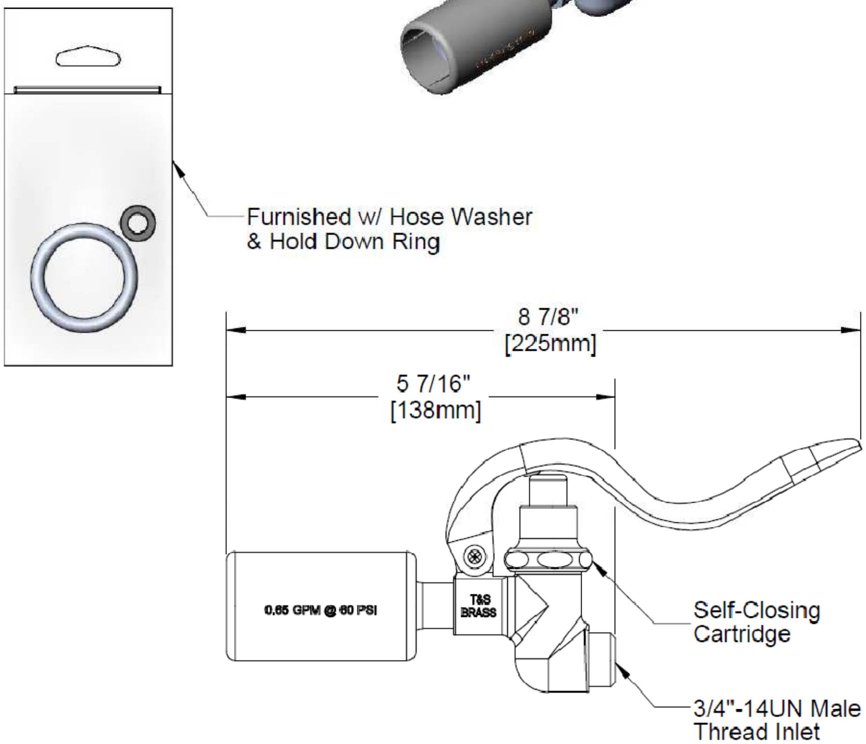
Customer/Wholesaler______________________________

Contractor______________________________________

Architect/Engineer________________________________

EPAct 2005 Compliant





Product Specifications:	Drawn	Checked	Approved
Self-Closing Pre-Rinse Spray Valve w/ 0.65 GPM Spray Nozzle	JRM	DMH	JHB
	Scale: 1 : 2		Date: 9/01/09

Sheet: 1 of 2

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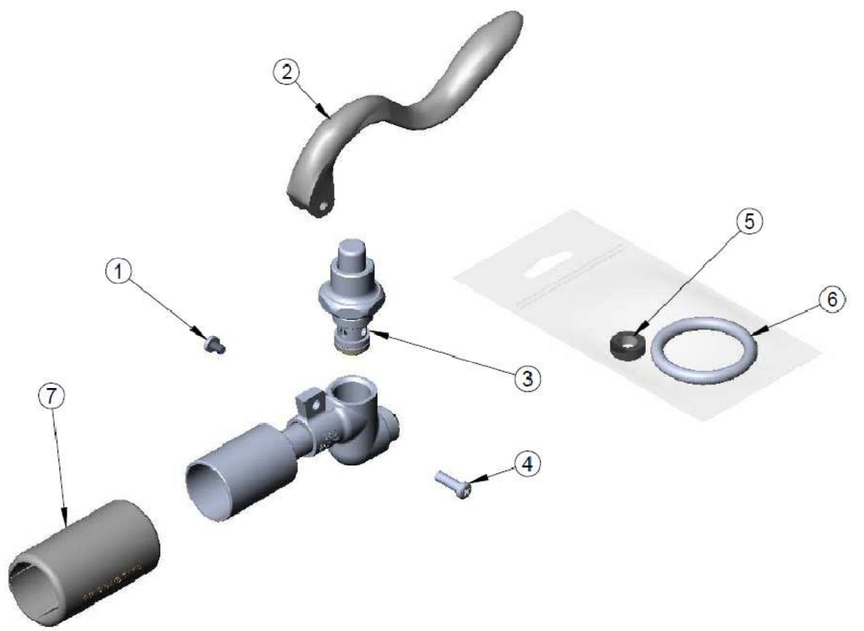
Travelers Rest, SC: 800-476-4103 Simi Valley, CA: 800-423-0150 Fax: 864-834-3518 www.tsbrass.com

Model No. **B-0107-C**

Item No.

ITEM NO.	SALES NO.	DESCRIPTION
1	003199-45	Handle Screw, Spray Valve
2	001120-45	Spray Valve Handle
3	002856-40	Bonnet Asm, Spray Valve
4	003198-45	Handle Nut, Spray Valve
5	010476-45	#27 Washer
6	000907-45	Ring, Spray Valve Hold Down
7	017709-45	Shield, Low Flow 0.65 GPM



Product Specifications:

Self-Closing Pre-Rinse Spray Valve w/ 0.65 GPM Spray Nozzle

Drawn	Checked	Approved
JRM	DMH	JHB

Scale:	Date:
NTS	9/01/09

Sheet: 2 of 2

T&S BRASS AND BRONZE WORKS, INC.
2 Saddleback Cove / P.O. Box 1088
Travelers Rest, SC 29690

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Model No. EB-0107-C

Item No.

This Space for Architect/Engineer Approval

Job Name__________ Date______

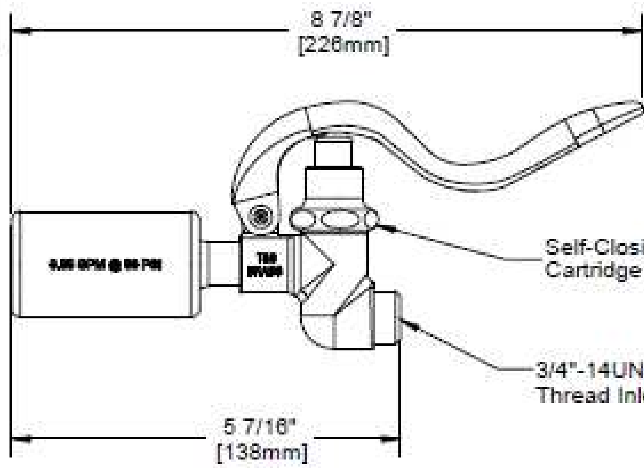
Model Specified__________ Quantity______

Customer/Wholesaler__________

Contractor__________

Architect/Engineer__________

EPAct 2005 Compliant



Product Specifications:

Self-Closing Pre-Rinse Spray Valve w/ 0.65 GPM Spray Nozzle

Drawn	Checked	Approved
JRM	DMH	JHB
Scale: 1 : 2		Date: 9/01/09

Sheet 1 of 2

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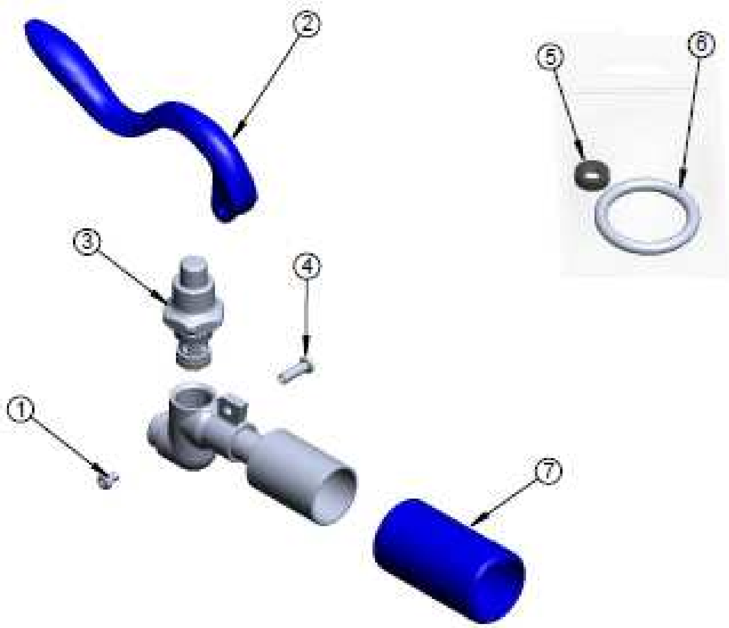
Model No. EB-0107-C

Item No.

ITEM NO.	SALES NO.	DESCRIPTION
1	003199-45	Handle Screw, Spray Valve
2	001120-45	Spray Valve Handle
3	002856-40	Bonnet Asm, Spray Valve
4	003198-45	Handle Nut, Spray Valve
5	010476-45	#27 Washer
6	000907-45	Ring, Spray Valve Hold Down
7	017710-45	Shield, Low Flow 0.65GPM



Product Specifications:

Self-Closing Pre-Rinse Spray Valve w/ 0.65 GPM Spray Nozzle

Drawn	Checked	Approved
JRM	DMH	JHB
Scale: NTS		Date: 9/01/09

Sheet 2 of 2

Nozzle #1 Data Recording Sheet

Make	T&S Brass		
Model	B-0107-C & EB-0107-C		
Rated Flow Rate	0.65		
Measured %/rated	1%		

Measured Flowrate		
	#/H20	gpm
Test #1	5.4	0.65
Test #2	5.385	0.65
Test #3	5.37	0.64
Average	5.3850	0.6459

Measured Cleanability Times (sec)		
TEST 1	TEST 2	TEST 3
20.97	19.89	21.89
22.17	18.88	20.81
20.08	21.83	20.91
19.04	19.47	24.59
19.9	19.49	18.5
21.19	20.4	20.46
22.76	20.47	21.07
19.38	19.42	23.37
20.83	17.77	22.13
22.78	18.7	20.71
21.67	21.83	21.48
18.28	21.67	18.18
18.89	22.87	20.07
23.33	22.8	17.6
22.05	20.12	20.02
18.93	22.94	18.29
20.63	22.01	20.13
23.54	21.19	23.06
19.93	20.49	20.29
21.99	21.95	22.66
Average	Average	Average
20.92	20.71	20.81

Nozzle #2 Data Recording Sheet

Make	T&S Brass		
Model	B-0107-C & EB-0107-C		
Rated Flow Rate	0.65		
Measured %/rated	2%		

Measured Flowrate		
	#/H20	gpm
Test #1	5.335	0.64
Test #2	5.31	0.64
Test #3	5.31	0.64
Average	**5.3183**	**0.6379**

Measured Cleanability Times (sec)		
TEST 1	**TEST 2**	**TEST 3**
19.37	19.46	22.33
20.64	20.93	23.14
19.15	22.27	19.4
20.04	19.62	23.13
22.13	20.03	20.87
20.4	21.33	21.98
22.32	27.9	20.23
21.33	22.35	22.93
22.13	22.37	21.53
23.01	20.49	20.02
20.04	21.67	20.37
20.5	22.05	22.26
20.12	22.67	20.47
25.55	24.73	24.24
21.33	21.49	22.4
18.63	21.47	19.35
19.3	19.49	20.88
21.8	23.58	22.29
21.34	22.27	23.33
20.37	20.93	19.29
Average	**Average**	**Average**
20.98	**21.86**	**21.52**

Nozzle #3 Data Recording Sheet

Make	T&S Brass		
Model	B-0107-C & EB-0107-C		
Rated Flow Rate	0.65		
Measured %rated	2%		

Measured Flowrate		
	#H20	gpm
Test #1	5.305	0.64
Test #2	5.32	0.64
Test #3	5.345	0.64
Average	5.3233	0.6385

Measured Cleanability Times (sec)		
TEST 1	TEST 2	TEST 3
19.57	20.23	20.22
19.94	23.74	21.73
22.13	18.58	19.84
19.47	19.31	21.86
22.56	20.91	22.42
21.39	21.97	20.67
20.47	21.32	19.92
20.73	21.07	20.46
22.42	20.83	20.95
24.9	21.44	23.09
21.29	20.25	24.91
20.99	23.64	20.15
21.48	23.93	22.42
20.32	21.56	21.24
23.07	20.11	20.51
20.35	23.64	21.67
23.39	20	21.03
20.98	20.96	22.16
21.21	21.88	21.06
21.03	23.4	20.56
Average	Average	Average
21.38	21.44	21.34

VITA

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