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INTERIM PROJECT REPORT

VERIFYING METHODS FOR DETECTING CROSSOVER IN DOMESTIC HOT WATER DISTRIBUTION

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PREFACE

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Verifying Methods for Detecting Crossover in Domestic Hot Water Distribution is the interim report for the Domestic Hot Water project (Contract Number PIR-12-030), conducted by Enovative Group Inc. The information from this project contributes to Energy Research and Development Division's Buildings End Use Energy Efficiency Program.

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ABSTRACT

Crossover is the result of a faulty fixture valve that allows the unintended and counterproductive flow of hot water into the cold-water line and cold water into the hot-water line. If left undetected, crossover could pose a significant challenge to energy efficiency efforts in California.

This study establishes the best methods for detecting crossover in a domestic hot water system. The research team at Enovative Group began this study by interviewing recognized industry experts to collect a wide variety of test procedures for detecting crossover. These methods were then examined in a controlled lab environment, where crossover was artificially induced, to determine the reliability and accuracy of each method in detecting the presence of crossover in a traditional domestic hot water distribution system.

Other Public Interest Energy Research studies have established that up to one-third of energy used for hot water is lost in the distribution system. Up until now, crossover has remained a cloaked and unaccounted for issue in the area of domestic hot water distribution. The results of this study will identify the most reliable, cost-effective methods for detecting crossover and, in doing so, will spotlight crossover as a potentially prevalent contributor to hot water energy loss.

Due to the unique nature of crossover and related symptoms very little research and scientific data exist. The lab testing of the above-mentioned methods proved some methods were able to detect crossover consistently using practical and inexpensive tools that are readily available.

Keywords: Crossover, balancing, central domestic hot water distribution system, recirculation loop, mixing valve, energy efficiency

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EXECUTIVE SUMMARY

Introduction

This interim report examines what crossover is, why it occurs, and the best standard practices for detecting its presence in a hot water distribution system. By expanding the understanding of crossover, the determination of crossover's likely presence across millions of residential and commercial buildings in California will be possible.

Crossover is when hot water bleeds into the cold water pipe and/or cold water flows into the hot water pipe from the faulty mixing valve of a fixture. Crossover is a potential flaw in every domestic hot water distribution system or wherever hot and cold water subsystems meet at a fixture. In other words, crossover can occur in single-family homes, multifamily dwellings, condominiums, hotels, motels, resorts, skyscrapers, dormitories, barracks, hospitals and prisons. To the extent that crossover is taking place is not yet known, but with such widespread and far-reaching application, every undetected occurrence of crossover can quickly add up to an unsustainable amount of wasted water and lost energy.

Crossover is a critical energy efficiency issue, which up until now has remained virtually ignored or overlooked. Detecting crossover is uniquely difficult in that most often the presence is asymptomatic, or worse, the symptoms are mistakenly associated with other unrelated issues in the distribution system, such as a failed recirculation pump, leaky pipes or a low temperature setting on the water heater. Focusing on the wrong cause allows crossover to continue, undiagnosed and uncorrected, to degrade the end user's hot water experience while wasting a great deal of water and energy and water.

According to the most current research presented by the California Utilities Statewide Codes and Standards Program of the total energy input of a central domestic hot water system, only one-third of that energy achieves its intended destination at the tap. This report will bring crossover to the forefront of the energy efficiency discussion and create a foundation of data for additional research. Is it possible that crossover is a significant contributor to the two-thirds of energy waste and is not only detectable, but easily fixed? Further studies in this area should be instrumental toward implementing industry standards of detecting crossover, helping to shape future building codes, and most important, saving California ratepayers the cost of wasting energy.

Project Purpose

This study, in part, examined a set of methods for detecting crossover. The research team tested each method in a controlled lab environment where crossover has been intentionally introduced through a flawed mixing valve. The objective was to determine the most consistent methods and in what circumstances were some methods able to perform better than others. With little precedent to go by, the research team began by collecting recommendations and suggestions from all levels of professionals working in the hot water industry who might have an idea or theory about crossover. After interviewing industry experts and researching the issue, the research team based its experiments around testing the following methods: Pressure gauge method; Water flow method; Eatherton method; Temperature differential method; Pump control method; and the Water meter method.

- Pressure Gauge Method- The method of detecting the presence of crossover in a building with a central hot water system, whereby a pressure gauge is inserted on the hot water system, incoming cold water feed is closed, and hot water is then let out. The pressure gauge needle will drop as hot water is let out, as there is no incoming cold water to re-pressurize the system. Once the hot water stops letting out, the needle will either stay stationary (no crossover), or the needle will move up (crossover), indicating that hot water system is being re-pressurized through an intrusion of cold water somewhere in the building.

- Water Flow Method- The method of detecting the presence of crossover in a building with a central hot water system, whereby the incoming cold water feed is closed and the hot water is drained from the building. In this scenario, water will eventually cease coming out once all of the hot water has been drained from the building. However, if there is crossover in the building, the water will continue to come and the building will never drain, as cold water is creeping in from the fixture failure points.

- Eatherton Method- Named for Mark Eatherton, Plumbing Engineer Extraordinaire, this method will detect whether there is crossover at a specific fixture in a building. The test requires removing a shower valve trim plate and exposing where the hot and cold water pipes go into the mixing valve. Placing your hand on each of the pipes, you will feel that one is cold and one is hot. Have someone turn on the hot water for the nearby lavatory sink and, if there is bad cartridge in the shower mixing valve, the pressure drop will induce crossover through the hot side and you will feel the temperature change from hot to cold immediately.

- Temperature Differential Method- This method can be used to detect crossover in a building with a central system. This is done by monitoring temperatures of the supply temperature and return line temperatures. When there is crossover there are times when the return line will drop in temperature due to cold water intrusion on the loop

- Pump Control Method- The method is for detecting crossover in a building that has a central hot water system using a recirculation pump. Generally these pumps that exist in buildings operate on a constant 24 hours a day, 7 days a week basis, and provide enough hot water flow in the building that it will mask any crossover occurring the building. By providing a control for the pump (which is now a prescriptive requirement under California's Building Energy Efficiency Standards) often times this will cause the crossover be more felt and thus cause tenants to complain. While the pump control itself cannot detect the crossover, it will make the symptoms more pronounced to users in the building, and this will be the indicator.

- Water Meter Method- The method of detecting crossover in a building is by observing the direction of flow in a water meter. If the meter is ever observed to be spinning backwards, then this is an indication that there is crossover in the building.

This study outlined the steps for testing each method and verified results regarding an otherwise hidden problem and established a new reference guide for the most effective and accurate methods for detecting crossover. This research may help broaden the discussion of energy efficiency in the areas of hot water distribution as it relates to improved building codes, and further funding for energy efficiency research, and development of new technologies.

The research team:

- Collected relevant, reliable information regarding a variety of detection methods for crossover from industry experts and certified professionals with any knowledge related to the issue
- Designed and implemented a test platform equipped with the ability to conduct experiments with and without crossover present in order to verify each method scientifically
- Created a report based on the results of each method being tested against the conditions of the test platform (that is, with or without crossover) and documented the data for peer review
- Produced an instruction manual that describes the steps for implementing the appropriate detection methods in buildings to be used by plumbing, energy efficiency, and water conservation professionals
- Published and distributed the findings of this research report through established industry channels to the appropriate stakeholders, as well as other technology transfer activities

Project Results

The research team verified, recorded, and analyzed the test results to determine the best recommendations for detecting crossover. Each method was repeatedly tested then rated for consistency and in some cases used in combination to achieve the most accurate detection. Some methods work better to detect crossover building-wide, whereas other methods can be used to pinpoint the exact location of the problem. Distinguishing the best methods from those based on anecdotal evidence will help establish the science behind crossover, the best methods for detecting it in a hot water distribution system and the most effective protocols for correcting it (Table 1 summarizes the results of the crossover detection methods analyzed in this project).

Table 1: Results of Verifying Methods of Crossover Detection

Method	Scenario 1 Results	Scenario 2 Results	Verification	Notes
Pressure Gauge Method	Detected	Not Detected	Method Validated	Quickest, building-level test
Water Flow Method	Detected	Not Detected	Method Validated	Building-level and pinpointing detection possible
Eatherton Method	Detected	Not Detected	Method Validated	Pinpointing detection possible, non-invasive
Temperature Differential Method	N/A	N/A	Invalid	Can be indicative of crossover
Pump Control Method	N/A	N/A	Invalid	Discarded, but may reveal crossover symptoms
Water Meter Method	Detected	Not Detected	Method Validated	Only possible in some buildings

Project Benefits

The research developed from this project aims to make typical hot water distribution in California substantially more efficient than current data models provide.

The goals of this project are:

- Raise awareness of crossover and its effect on energy efficiency efforts.
- Review a list of potential test methods for detecting crossover and validate the best protocols for detection.
- Establish a best standard practice for detecting crossover.
- Create an instruction manual for detecting crossover based on test results.
- Develop a pathway to increasing the amounts of water and energy saved in domestic hot water systems.
- Produce the prerequisite research for further studies and future projects to determine the prevalence of crossover and solutions for its permanent eradication.
- Disseminate fresh information and verified data to concerned stakeholders

This report offers a new scope of scientific research that will be instrumental to the scientific community, as well as legislators and policy makers interested in energy efficiency. The data should help advance general awareness of crossover and the best methods for detecting it. The more information about crossover is available, the better equipped stakeholders will be to develop more efficient hot water distribution systems, improving building codes, and promoting competition in the marketplace for new solutions.

CHAPTER 1: Introduction

1.1 Crossover's Significance

Crossover occurs when a fixture's mixing valve malfunctions and allows cold water to infiltrate the hot water subsystem and vice versa. Crossover can happen in any building with hot and cold water pipes that intersect a fixture. The number of buildings where crossover might cause a problem could run in the millions. The potential impact on domestic hot water (DHW) energy waste is astonishing. Up until now, no scientific research has been dedicated to determining the pervasiveness of this issue and developing the parameters towards calculating how much water and energy is wasted annually by crossover.

With so many different layout designs between domestic hot water systems specific to each unique building, symptoms of crossover are equally varied and easily overlooked or mistaken for another issue. The most common signs and symptoms caused by, but often not attributed to crossover are:

- Warm Water in Toilets
- Water Temperature Fluctuations and Surges
- Impossible Water Waits (i.e. hot water does not arrive even after the volume of cold water in the hot water pipes have been purged from an open fixture)
- Abnormal Water Pressure
- Excessive Heat Loss in the Hot Water Distribution System
- Scalding Hot Water, Hot Water out of the Cold Tap
- Long Waits for *Cold* Water

Undiagnosed crossover will continue to erase all improvements made towards a more energy efficient hot water delivery system. The information provided by this report will prove to be instrumental for enhancing the necessary understanding of crossover, its symptoms and effects and even more importantly, the continuous drain it inflicts on California's water and energy resources.

1.2 Past Research

As in normal circumstances, the research team began the study of crossover by referencing its historical data and previous reports. They were surprised to find very little scientific data related to the issue. One case in point is a study that was conducted in 2011 (McNamara, Gruen, Laver, & Perlman, 2011). Within the study, a section was dedicated to crossover as a general topic of interest, but did not pursue direct testing or data collection around detection methods nor its impact on energy loss. While the findings of the previous study of crossover fell short of offering any conclusive evidence, it has provided an initial starting point to this current report.

The list of professionals started with plumbing and maintenance technicians, plumbing engineers, building managers, mixing valve manufacturers and expanded to include water and energy efficiency experts. Such a cross-section of people in the industry would provide a wide range of helpful opinions and insights. Some spoke directly to the symptoms and effects of crossover, bringing into the discussion the tenant's experience of temperature and pressure fluctuations, long waits for hot water and overall degradation of the distribution system. Some of the interviewed offered ideas or theories for the best methods to detecting crossover, some of which proved to be more reliable than others. Manufacturers, who were not aware of crossover, had valuable information regarding the design of certain fixtures and mixing valves that could lead to preventing crossover.

The next step for the research team was to create a list of likely experts and technicians in the field of hot water distribution, who might have relevant theories, thoughts and suggestions about how best to conduct testing of crossover in a controlled lab platform.

These in depth discussions gave the research team a baseline of anecdotal data to build further research upon. Many industry articles and plumbing publications added supplemental guidelines that helped define the line between what crossover is and what is often mistakenly perceived in place of it. Lastly, the research team attended energy conferences and industry events specific to hot water issues hosted by credentialed experts in order to learn every detail of a hot water distribution system that might enhance and substantiate the findings of this report.

Table 2 lists stakeholders interviewed and the benefits of their knowledge.

Table 2: Profiles of Stakeholder Interviews

Expert Type	Importance To Crossover
Plumbing Contractor	Symptoms, Misconceptions, Possible Methods
Plumbing Engineer	Common Plumbing Layouts and Designs
Shower Valve Manufacturer	Design of Fixtures, Causes of Fixture Failure
Building Owner/Manager	Tenant Complains, Prevalence

Once the research team identified specific experts in the industry who were available and accessible to discuss crossover in greater detail, several rounds of interviews were conducted by phone and email. The information gathered from these conversations helped the research team to determine the range of methods of detecting crossover that appear in this report.

1.3 Crossover Detection Methods

The following descriptions are of the detection methods gathered from the interviews.

1.3.1 Pressure Gauge Method

The pressure gauge method requires a standard pressure gauge that is commercially available and relatively inexpensive. The pressure gauge can be attached to the domestic hot water system anywhere on the hot water subsystem (i.e. on a hot water pipe), however it is recommended to use a hose bib on a return line, which is commonly available.

To start, close the valve to the cold water supply that feeds into the water heater, while keeping the cold water supply to the cold water subsystem open.

Then release hot water from the hot water subsystem via any fixture, thus relieving pressure on the hot water subsystem. After some or all of the pressure is released, the fixture should be closed so that water is no longer coming out.

If crossover is present, then the pressure gauge will show the pressure in the hot water subsystem slowly rebuilding to normal. If crossover is not present, the pressure gauge will continue to register at lower levels or even come to rest at zero pressure, but should not increase.

1.3.2 Water Flow Method

The Water Flow Method is the most widely recommended method as suggested and confirmed by multiple sources during the industry interviews. The Water Flow Method is preferred because it does not require extra equipment to perform

First, the cold water supplied to the hot water subsystem is shutoff via a valve on the cold water feed to the water heating system. Water supply to the cold water subsystem is not turned off.

Then, open a fixture or hose bib to drain the water from the hot water pipes.

If crossover is occurring, the water flow will not stop, even after the hot water has completely drained, and the water coming out of the fixture will eventually turn cold. If crossover is not occurring, then the hot water pipes will eventually drain and water will cease to flow.

1.3.3 Eatherton Method

The Eatherton method, which is properly named after Mark Eatherton, the plumbing engineer who created this particular procedure, consists of testing each fixture individually, beginning with the shower valve in the housing unit that is experiencing hot water issues.

Figure 1: Exposed Shower Valve after Removing Faceplate

The faceplate of the shower valve is removed, leaving the shower's mixing valve exposed. The hot side of the shower valve is heated by turning on hot water until the user gets the hottest water and then turning the shower valve back off.

A nearby lavatory faucet hot water is then turned on, while the user feels the hot side of the exposed shower's mixing valve. If there is crossover, the shower mixing valve will rapidly cool down because the lavatory is pulling cold water through the shower mixing valve, thus rapidly cooling down the hot side of the shower mixing valve.

If there is not crossover the shower mixing valve will remain hot, because cold water is not crossing over, and thus the shower valve will remain heated.

1.3.4 Temperature Differential Method

The temperature differential method involves adding temperature sensors to the hot water supply from the water heating system and then on the return line of the hot water system. The temperatures are then logged.

If the logged data shows fluctuations in temperature due to cold water coming down the return line, which is usually easier to determine by logging the minimums for a given interval and comparing to the temperature averages for the same interval period, then this may indicate crossover.

Alternatively, if there is an excessive temperature differential between the hot water supply and the hot water return, this could also indicative of crossover.

1.3.5 Pump Control Method

The pump control method relies on controlling (i.e. turning on and off) a recirculation pump with a temperature sensor on the return line, which can be achieved with an aqua-stat or demand controller.

If problems arise from ceasing to recirculation of the hot water, then a tenant will complain because the return may have hot water, keeping the recirculation pump off, but within the building the cold water is crossing from one faulty valve and feeding the next fixture. Since the pump control is on the hot water return, which is normally the coolest point on the hot water subsystem, it means that there is an even cooler point within the building, which could mean crossover.

1.3.6 Water Meter Method

The water meter method required a water meter be installed on both the hot and cold water pipes that are feeding an individual unit.

If there is crossover, one of the water meters will spin forward, while the other water meter is spinning backwards. If crossover is not there, then the water meters should both only spin forwards when someone is using water in the dwelling unit.

CHAPTER 2:
Developing a Test Platform For Crossover Research

With the previously mentioned methods gathered and discussed at length, the next step for the research team was to determine a test plan for verifying if the methods actually detected crossover, how consistently they detected crossover, whether the method provided a practical and cost effective procedure that could be used to meet state-wide demands, and most importantly, whether each method could detect crossover consistently without showing false positives.

2.1 Test Platform Benefits

When planning for this phase of the study, the research team had a choice between two valid options for verifying the crossover detection methods. The detection methods could either be tested at an existing building or field test site, or they could be tested in a controlled lab environment. The research team chose the latter option, and designed a controlled environment, referred to as the "test platform."

Figure 2: Test Platform

The field test was ruled out as an option because of the numerous variables that would be hard to account for, expense of rigging a building with sensors, and because of the excessive burden on a potential building and its tenants required to run the appropriate tests.

By building a test platform and studying the detection methods in a controlled environment, the research team had unfettered access to the platform, was able to run the experiments more cost effectively, and could configure and build the system to the exact needs of the study.

The only difficulty that creating a test platform created was the ability to appropriately mimic a live building with occupants as well of normal wear and tear. These difficulties did not outweigh the benefits of creating a test platform in a controlled environment.

2.2 Test Platform Design

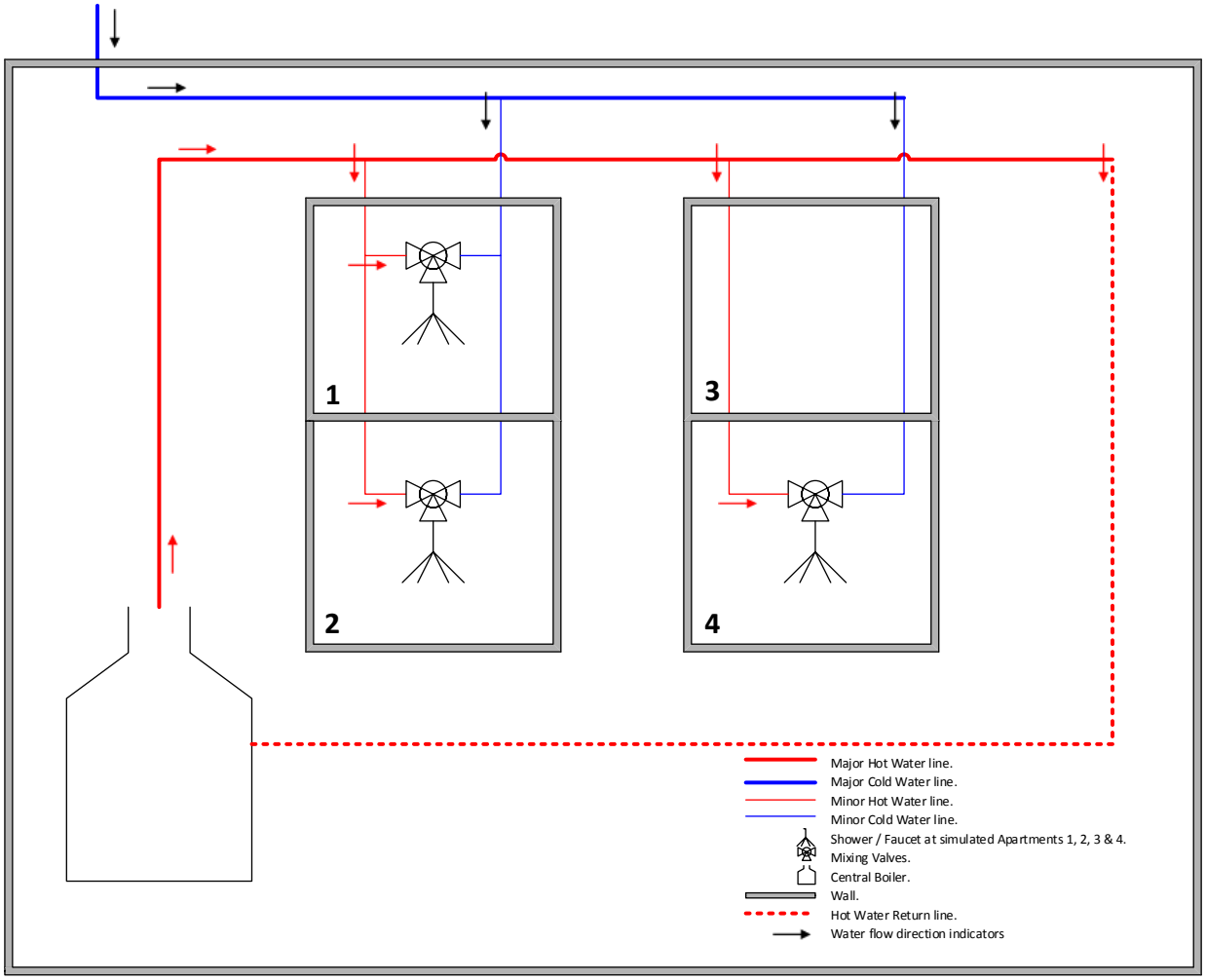
The test platform was a scaled down, simplified model of a typical multifamily building's domestic hot water system, designed specifically to simulate the normal conditions of hot water distribution. The pipes and valves were kept exposed so that the layout could be easily reconfigured, if necessary, and accessible to adding or moving data recording instruments as needed. In essence, the research team built itself a miniaturized domestic hot water system and then added the appropriate temperature and pressure sensors for data acquisition. Lastly, the research team added a few non-standard features such as a pressure boosting pumps, in order to have better control of the variables like system pressure.

2.2.1 Platform Design Description

The test platform was fed by a cold water line (city supply) and heated by a standard hot water heater. All the piping was copper. The test platform included a recirculation loop with a recirculation pump. Recirculation loops are a standard aspect of the majority of domestic hot water systems in multifamily building as building codes stipulate the need for recirculation when the hot water supply pipe is over 50 feet long.

The test platform ran two branches off of the hot water supply that fed separate shower fixtures. This simulated the conditions of two, side by side, or lateral apartment units. One of the branches fed two shower fixtures that were stacked vertically. This recreated the typical conditions of a hot water distribution system in a two-story tenement.

Figure 3: Test Platform Designed To Simulate Two-Story Building



There were a total of three shower valves. Two of the shower valves were pressure balancing, while one of the shower valves was still single-lever, but not pressure balancing.

There was a pressure-reducing valve located on the cold water feed pipe to the water heater, after it branched off from the city supply. This valve was installed with a bypass so that it could be easily added in or taken out depending on the scenario or conditions of the experiment. This valve was in a position whereby it would only reduce the pressure of the hot water subsystem. In other words, the research team could control the pressure of the hot water pipes *separately* from the pressure on the cold water pipes.

Figure 4: Detail of Sensors around Shower Mixing Valve

In the few reports that mention crossover, it is theorized that crossover is created from pressure differences in or pressure imbalances between the hot and cold water pipes or subsystems. The pressure reducing valve gave the research team the ability to configure the test platform to produce these pressure differences or remove them, according to what the experiment called for.

There was a pressure-boosting pump (Grundfos Model: CRIE1-9) on the cold water supply pipe after the cold water branched off to feed the water heater. This enabled the ability to add pressure to the cold water subsystem independently of the hot water subsystem.

2.2.2 Test Platform Data Acquisition

The test platform was instrumented with various sensors in order to digitize the tests as well as to gather potentially useful data that could provide further information about crossover.

The core equipment for data acquisition was an Opto22 programmable automation controller consisting of the following product numbers (Table 3):

Table 3: Opto22 Equipment for Data Acquisition

Opto22 Part Number	Number of Inputs	Description
SNAP-PAC-R1	N/A	Programmable Controller, the brains
SNAP-IDC-5	4	Digital Inputs

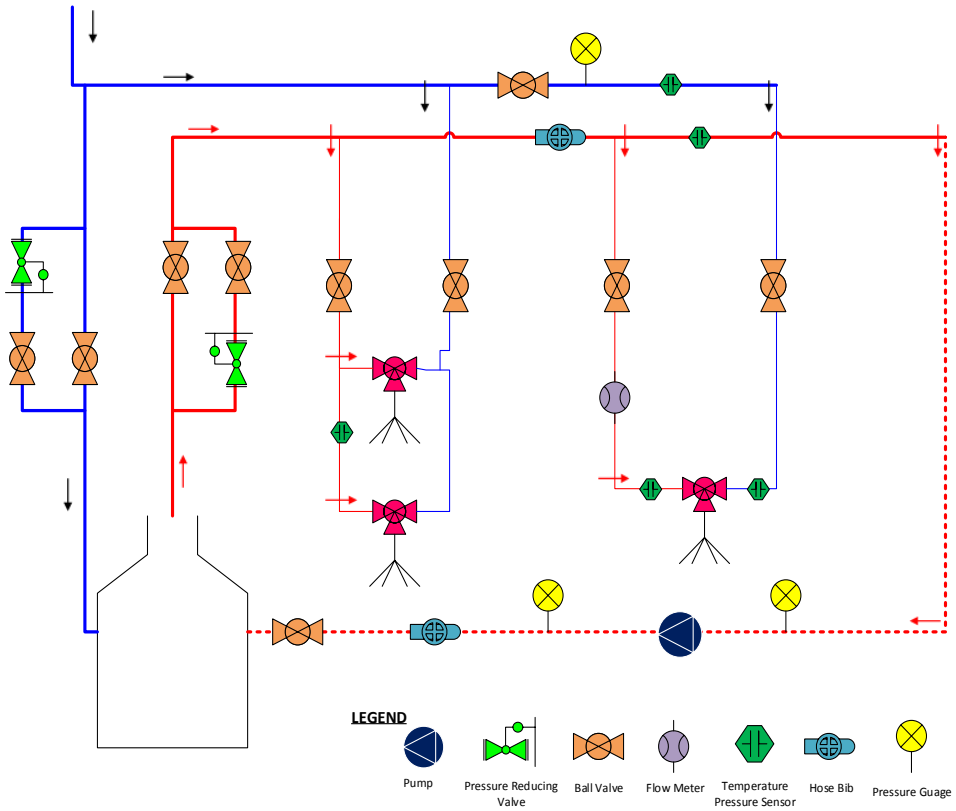
Opto22 Part Number	Number of Inputs	Description
SNAP-ODC-5	4	Digital Outputs
SNAP-AIR400K	4	Thermistors (Temperature sensors)
SNAP-AIV-8	8	Voltage Inputs, used for gather temperature and pressure data

The Opto22 is system that allows you to utilize various modules and thus capture various types of sensors. The primary sensor was a combination pressure and temperature sensor that was in-

line with the water in the pipes. The data acquisition system was setup to record data from the sensors in one-second intervals.

See below diagram of the sensor locations (Figure 5).

Figure 5: Test Platform Sensors



There was also a water meter was installed on the hot water side adjacent to the shower valves. The water meter was turbine type, with little restriction to water flow, and would not create a situations that differed from real world applications. The flow meter was connected to a standalone display that could not be connected to the data acquisition system. The display could show the totalized water that had flowed past it or toggled to show the current rate of water flow past the meter. The water meter would only show flow going in one direction, and thus uni-directional. The research team installed the meter to only show water flowing *away* from the shower valve.

In a typical situation, water always flows towards the shower valve to exit the pipes out of the showerhead, and thus a water meter setup in such a fashion should *never* register any water flow. In situations of crossover, water is flowing through the shower valve backwards, and would then register flow on the water meter installed backwards. With this setup, the water meter is only registering crossover flow and not normal shower valve usage. This is the ultimate way to prove whether or not crossover existed on the test platform, and the data was then corroborated with temperature data as further evidence.

The next step in the study was to then induce crossover artificially, and the test platform was setup in a way for the research team to verify when crossover had been created.

2.3 Creating Crossover Artificially

Once the test platform was built, the research team then set out to induce crossover artificially within the test platform. Going into this task was difficult because the test platform had new fixtures, and there is no information that exists on how to induce crossover or to what level of wear and tear a shower valve had to experience in order to start to allow crossover.

Since the test platform was structured in a way that the research team would recognize crossover as soon as it started to occur, the research team had to run a series of experiments in the attempt of inducing crossover.

The first of many tests showed no signs of crossover. The first sign of crossover was when the research team created an unrealistic scenario that would never exist in the real world. The research team had created zero pressure on the hot water subsystem and full pressure on the cold water subsystem, but crossover did not occur until the non-pressure balanced shower valve was in use at the same time as one of the other shower valves.

This created a problem for testing the methods and was not ideal, because it required the shower valve to be open in order for crossover to occur. The research team believed crossover to occur through the valves even when they were not in use. At a minimum, it did prove crossover could occur with a brand new non-balancing shower valve (see note below) when it was concurrently in use with shower valves from nearby apartment units.

Note: In California, the current building codes (ASSE 1016) currently call for the use of either pressure balancing shower valves or thermostatic shower valves, for safety purposes of avoiding the possibility of scalding when using the shower valve, but the majority of existing buildings do not meet that standard as they were built before the language was adopted in 1996 [Powers 2007].

The research team went into the field to a location in Orange County that was known to have crossover. This particular multifamily building was unique in that it had submeters tracking both the hot and cold water pipes feeding an individual unit. An interview with an onsite maintenance person revealed that he had noticed that sometimes the hot water meter spun backwards while the cold water meter spun forwards and no one was in the apartment unit.

This indicated that crossover from the cold water pipe into the hot water pipes, created that pattern on the two submeters, and that crossover occurred even when there was no use of a faulty shower valve.

The mixing cartridge was then removed, and a new one installed. Afterwards the meters stopped spinning, indicating that the crossover problem was potentially fixed for that unit.

This cartridge was then inserted into one of the new shower valves in the test platform and the research team began further experiments, with a suspected bad shower mixing cartridge. This is similar to the guide published by Rikos plumbing engineering (Rikos, 2013).

Immediately, the test platform, via the cold-water meter began to show crossover. When a hot water tap was opened on an adjacent shower valve, the uni-directional flow meter, would

register crossover flows. The temperature sensor next to the water meter also became cool as cold water crossed through the shower valve cartridge to cool down the hot water pipes. The water meter along with the temperature data proved beyond a doubt that the research team had successfully created and induced artificially crossover in the test platform.

At that point in the study, the research team had all the necessary tools in place to test the methods for detecting crossover.

2.4 General Plan to Testing Crossover Methods on the Test Platform

The test platform was designed and equipped to mimic the functions of a hot water distribution system in an actual multifamily building. Additional attributes, like booster pumps and pressure valves, were introduced to the test platform that would allow the research team to control the presence or absence of crossover in the hot water subsystem. The research team could monitor the effects of crossover through multiple data points recorded by temperature, pressure and flow sensors. The data collected by the different sensors was then recorded by a centralized data acquisition system for further analysis.

In this controlled environment, each of the detection methods could be tested against two different scenarios. In Scenario 1, the test platform would be manipulated to produce crossover from the cold water subsystem into the hot water subsystem. In Scenario 2, the test platform would be manipulated to inhibit the presence of crossover in the hot water subsystem. The conditions established by each scenario were created in such a way to simulate the delivery of hot water in a typical building setting.

The following table (Table 4) shows the configurations for the Scenario 1 and Scenario 2 treatments of the test platform.

Table 4: Scenario 1 & 2 Comparison

Scenario	1	2
Pressure Hot Water Subsystem	60 psi	40 psi
Pressure Cold Water Subsystem	60 psi	60 psi
Pressure Reducing Valve –Hot Water Subsystem Setting	Set to 40 psi	Set to 40psi
Recirc Pump Status	Off	Off
Shower Valve 1	Active-not on	Active-not on
Shower Valve 2	Active-not on	Active-not on
Shower Valve 3	Active-not on (faulty cartridge)	Valved off
Results Notes	Crossover	No Crossover

Each detection method was then subjected to both scenarios. If the method was able to identify crossover in Scenario 1, and not detect crossover in Scenario 2, then the method was rated a valid result. If the method failed to detect crossover in Scenario 1 or found crossover in Scenario 2, then the method would have been discarded. If the method registered crossover in

Scenario 1 and Scenario 2, the method was subjected to additional testing to determine whether or not the method was susceptible to false positives.

The research team decided to run each detection method through both scenarios multiple times for additional data and thorough scientific verification. By subjecting each detection method under both scenarios, the research team could determine whether the method worked or not.

The results of each scenario were captured by temperature, pressure and flow meter sensors that were placed in strategic locations throughout the test platform. The data acquisition system was programed to log the data at 1-second intervals during the test.

An example of a portion of the logged data is found below:

	Date	Interval	P_SV3_C	P_SV3_H	T_WS_H	T_WS_C	T_SV3_H	P_WS_C	T_SV3_C	P_WS_H
PGaugeS1T3	02/05/2014	1	59.97	57.26	121.98	68.89	68.07	56.33	66.82	56.02
PGaugeS1T3	02/05/2014	2	60.2	57.3	121.98	68.84	68.62	56.6	66.85	56.31
PGaugeS1T3	02/05/2014	3	60.2	57.32	121.93	68.84	68.58	56.6	66.8	56.29
PGaugeS1T3	02/05/2014	4	60.22	57.36	121.98	68.86	68.02	56.6	66.85	56.28
PGaugeS1T3	02/05/2014	5	60.26	57.28	121.95	68.94	68.5	56.62	66.87	56.33
PGaugeS1T3	02/05/2014	6	59.99	57.26	122.1	68.86	68.02	56.39	66.66	56.35
PGaugeS1T3	02/05/2014	7	59.95	57.26	121.35	68.91	68.6	56.41	66.54	56.1
PGaugeS1T3	02/05/2014	8	59.93	57.26	121.4	68.31	68.62	56.41	66.61	56.06
PGaugeS1T3	02/05/2014	9	59.99	57.34	121.47	68.89	68.02	56.45	66.58	56.02

Each column in the table represents a different sensor tracking an element of the test. From left to right, the data points collected are as follows:

- Name of the Test
- Date
- Time / Interval (seconds)
- Pressure in PSI located on the cold water side of shower valve 3
- Pressure in PSI located on the hot water side of shower valve 3

- Temperature (Degrees Fahrenheit) of the Hot Water Supply
- Temperature (Degrees Fahrenheit) of the Cold Water Supply
- Temperature (Degrees Fahrenheit) on hot side of shower valve 3
- Pressure in PSI of the Cold Water Supply
- Temperature (Degrees Fahrenheit) on cold side of shower valve 3
- Pressure in PSI of the Hot Water Supply

Collecting the data in such time sensitive increments allows for a more accurate analysis and avoidance of overlooking any anomalies that might have occurred. Logging the data in charts such as this allows the research team to present their findings in quantifiable forms provided by the instrumentation. By classifying and organizing the results this way, the research team is providing a sound body of data that will be beneficial to future projects in this field and available for peer review. In addition, the scenarios conducted for each detection method were documented by video should such reference material be requested.

2.5 Field Testing and Overall Crossover Research Plan

Once the research was conducted and the data analyzed, the research team concluded that the test platform was more than adequate and ultimately sufficient to complete the goals of this phase of the study, "Task 2," (Appendix A). In an attempt to broaden their perspective of the data, the research team expanded the scope of testing and implemented some of the methods in real world field situations at actual building sites occupied by tenants.

This field experience provided the research team with direct insight to the required planning and preparation, budgeting, scheduling and general practicality of conducing crossover detection tests outside a controlled lab environment.

Such information will play an important role in establishing expectations and guidelines for testing detection methods in the field. Future phases of this study are focused around field tests that can benefit from considering the details covered in this report. From these findings, the research team will be able to move forward knowing beforehand the proper tools to use, which sensors are best at capturing critical data, and how to program the data acquisition systems for the highest level accuracy. Based on the knowledge established by the research team in the first phase of this study, the foundation has been set for the next step.

The next phase (Task 3) of the study will consist of a survey of 100 randomly selected buildings used as test sites for the detection methods already defined. The detection methods will be applied according to the test procedures established later in this report and the results will be recorded for verification. Analysis of the data will reveal, for the first time, a true picture of how pervasive crossover is and an approximate evaluation of how much energy it is wasting. Beyond this phase of testing and data gathering, the research team will begin to propose the most consistent and cost effective solutions to eradicating crossover permanently.

After that phase, the following phase (Task 4) of the study will implement the detection and correcting method of crossover while monitoring the building for energy savings. These

savings should provide a comprehensive understanding of how much energy would have been lost otherwise.

CHAPTER 3:
Testing Methods for Detecting Crossover

3.1 Pressure Gauge Method

3.1.1 Introduction

The Pressure Gauge method was formulated from an interview with a plumbing contractor that specializes in plumbing related services such as repairing existing pipes and valves and replacing water heating units and/or installing upgrades to existing systems as opposed to installing plumbing into new construction. The Pressure Gauge method is simple and straightforward and equally consistent in its detection of crossover. It requires the application of a standard pressure gauge, which is an inexpensive tool, sold at most general hardware stores. It is a method that does not require the use or draining of much water and can be completed quickly to detect crossover on a building-wide level, but not at the fixture or apartment unit level.

3.1.2 Brief Description

The Pressure Gauge method consists of attaching a pressure gauge to the hot water subsystem. Then the pressure to the hot water subsystem is turned off by closing the valve closest to the water heater while the pressure to the cold water subsystem remains open. Pressure is released from the hot water pipes by opening any fixture. Once the pressure in the hot water supply is allowed to reach its lowest point, one of two potential results will occur. Either the pressure in the hot water subsystem rebuilds to normal, which means it is receiving water from the cold water supply through a faulty mixing valve cartridge found in the shower valve, meaning crossover is occurring. Or, if the pressure in the hot water supply remains low or at zero, then the mixing valve cartridge is working correctly and crossover is not occurring.

3.1.3 Detailed Steps for Conducting the Pressure Gauge Method

Figure 6: Pressure Gauge Attached to a Hose Bib, on the Hot Water Return Line

1. Add pressure gauge to hot water subsystem. A Pressure gauge may already be installed which you can use. You can add one temporarily to a hose bib. It needs to be on the hot water subsystem.

2. Check pressure when the hot water subsystem is fully pressurized. If you installed on the hose bib you would now open the hose bib and wait for the gauge to stabilize. Take note of the pressure of the hot water subsystem once it has stabilized.
3. Close a valve on the cold water supply to the water heater. *Do not close the hot water supply nor close a cold water valve on the main cold water feed to the building*. The valve needs to be on the cold water line feeding only the water heater. The purpose of this step is to isolate pressure on just the hot water subsystem.
4. Relieve pressure on the hot water subsystem. You can do this by opening a faucet and make sure the faucet is set to run hot water, or another hose bib on the hot water subsystem. You could also trigger the TPR Valve on the water heater, but take care as this can get stuck slightly open if poorly maintained. The pressure gauge needle should show the pressure going down as the water is released. Once the pressure has reached at least half of the initial reading, or even zero pressure, close the valve or faucet that was opened.
5. Now that you have relieved pressure and your pressure gauge reading is a lot lower than where it was with full pressure on the hot water subsystem, if there is not crossover the pressure will stay low. If the pressure begins to increase back to normal, it is most likely an indication of crossover.
6. Special Note: The pressure can begin to creep back up without crossover occurring, if the shutoff-valve that you closed earlier in step 3 is faulty or leaking.

3.1.4 Pressure Gauge Method – Results

The following table summarizes the results of testing the Pressure Gauge method of crossover detection.

Table 5: Pressure Gauge Method Verification Results

Pressure Gauge Method Results Summary	
Test Platform Setup:	Results:
Scenario 1 (with crossover)	Crossover Detected
Scenario 2 (without crossover)	Crossover Not Detected
Pressure gauge method - Verified	

The above test results verify that the Pressure Gauge method is a reliable method for detecting crossover and is unlikely to result in false positives (i.e. detecting crossover when it actually is not there).

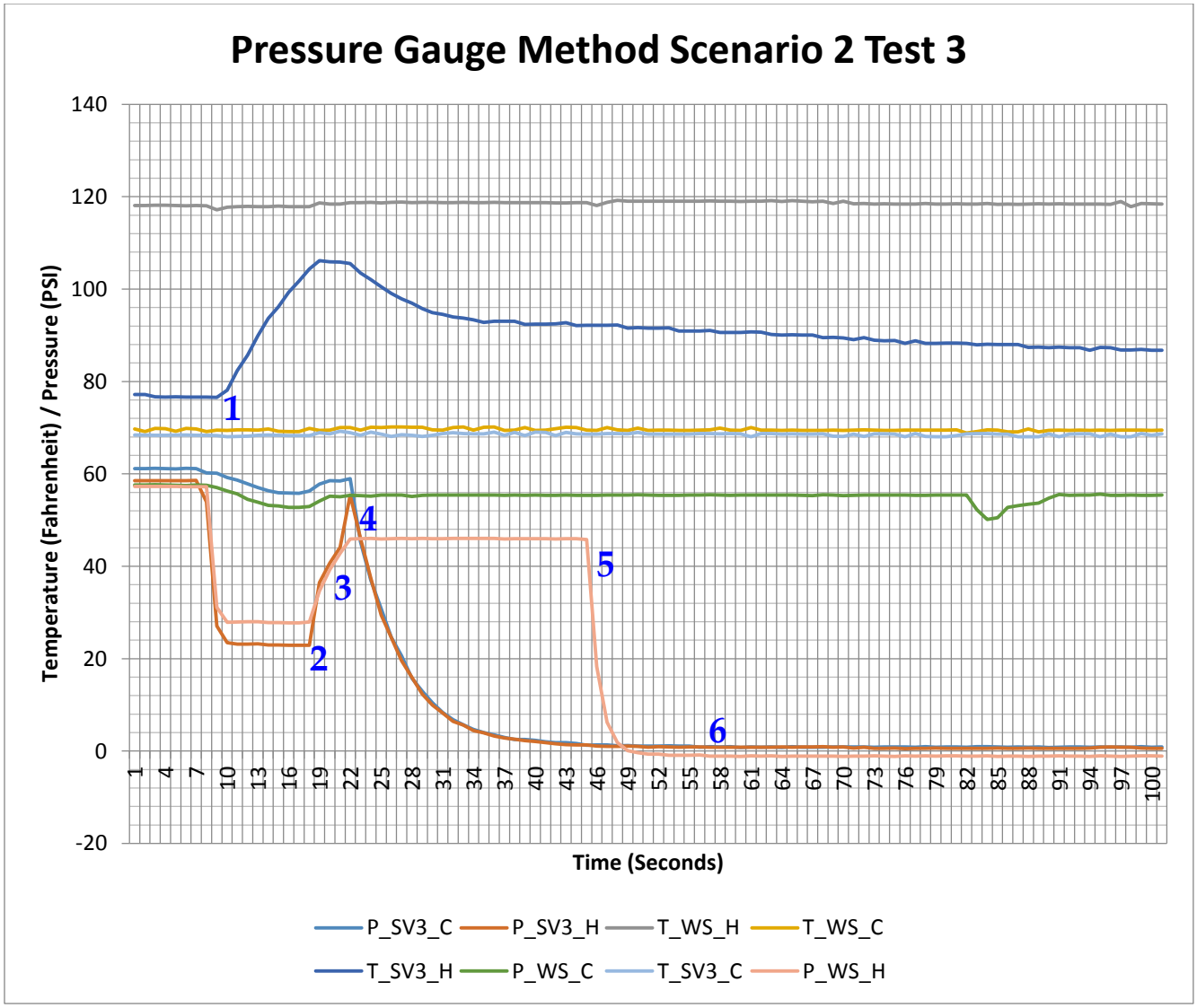
The research team was able to test this method at a field site that experienced some symptoms of crossover. The test was documented via video which is approximately three minutes in length, illustrating the method can be used with relative ease and speedily.

The results are further supported by the logged data. The charts below show the pressure gauge method being tested under each scenario.

The following table is to be used as a legend for **all** the charts and tables displayed from this point.

Abbreviation	Meaning	Legend
P	Pressure Data	P_WS_H
T	Temperature Data	P_WS_C
WS	Readings from the water Supply Line	T_WS_H
SV3	Readings from the 3rd shower valve in the Lab setup	T_WS_C
H	Hot Line	P_SV3_H
C	Cold Line	P_SV3_C
For example, 'P_WS_H" would represent the Pressure data obtained at the Hot section of the Water Supply Line.		T_SV3_H
		T_SV3_C

Figure 7: Pressure Gauge Method Scenario 2 Chart



Annotations from Figure 7 shown on the pervious page:

1. SV3 Hot section opened increasing temperature and dropping pressure.
2. SV3 Hot section turned off, regaining pressure
3. SV3 hot section isolated, dropping pressure but avoiding crossover
4. P_WS_H turned off preventing it from gaining full pressure and dropping P_SV3 fully.
5. Hose bib opened, relieving all pressure from hot sections of the system.
6. Pressure stays at zero indicating absence of crossover when the SV3_H was isolated.

The figure on the previous page (Figure 7) shows the pressure gauge method being tested on the test platform with the Scenario 2 treatment, a situation without crossover in the system.

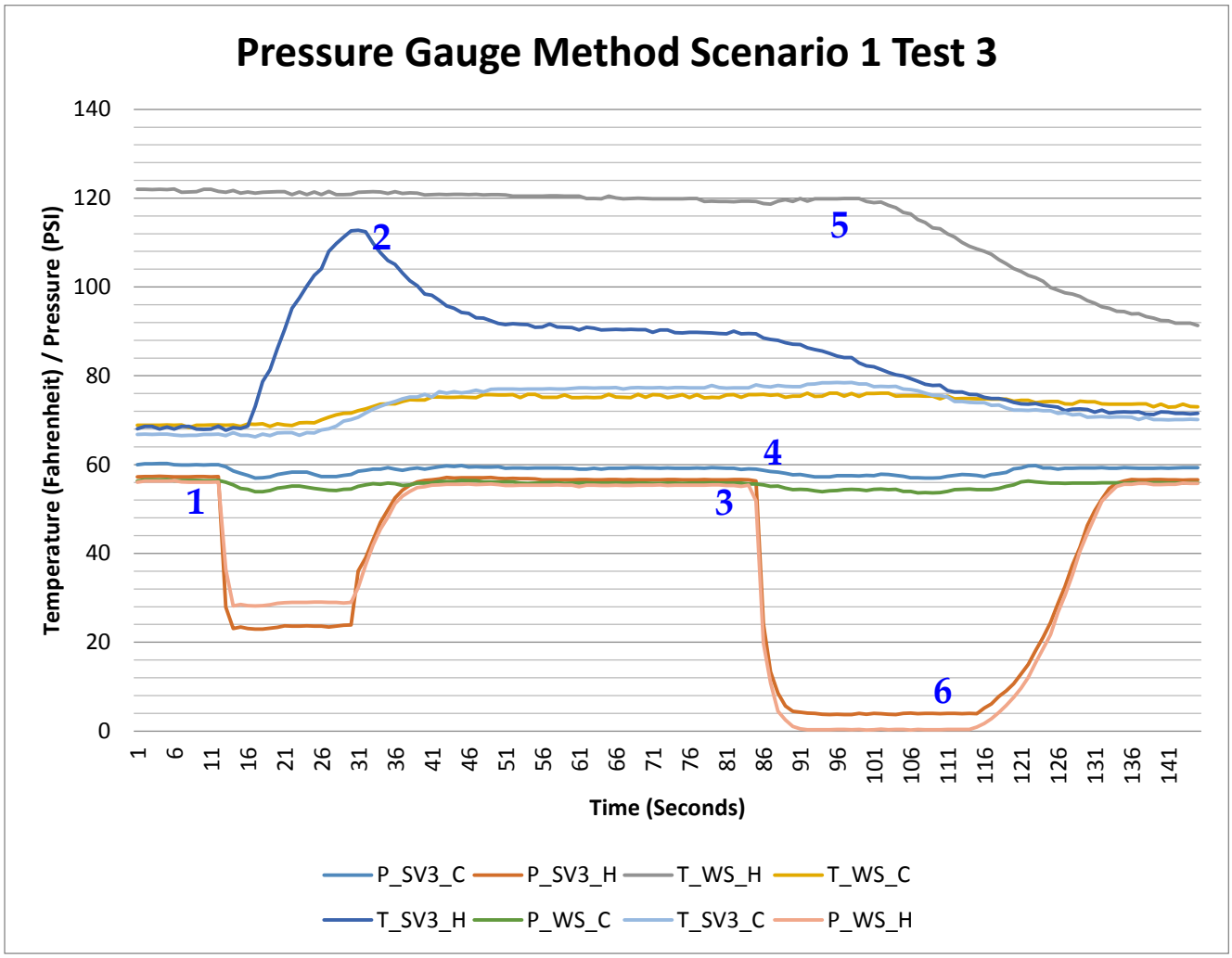
In the field, the result that the user will see that indicates there is not crossover, is that the needle on the pressure gauge attached to the hot water subsystem went down, and then never climbed back up (i.e. pressure dropped, and never rebuilt).

In the test platform, the corresponding data that was gathered by the data acquisition system is shown by the line labeled "P_WS_H." That line matches with what the user of the method would see when looking at the needle of the pressure gauge.

At about midway through the chart, the pressure goes down and at the end of the chart the line is continuing to stay at zero pressure. This means pressure was released from the hot water subsystem, and since there was no crossover, and thus no additional source of water pressure for the hot water pipes, the pressure could not be rebuilt.

Also the temperature of the hot water supply stays level (See line labeled T_WS_H), throughout the testing of the pressure gauge method. This is noted because the next chart showing the same method being tested, behaves differently. Without crossover the temperature of the hot water should stay hot, but with crossover the cold water can intrude into the hot water pipes, which then cools the temperature of the hot water pipes. This can cause a tenant complaint.

Figure 8: Pressure Gauge Method Scenario 1 Data



Annotations from the chart above:

1. Shower Valve 3 turned on causing drop in pressure and spike in temperature.
2. Shower valve 3 closed off causing pressure stabilization and temperature loss.
3. Cold line water supply inlet to heater turned off.
4. Hose bib opened causing pressure drop and instant crossover at about 1.4 GPM
5. Hot water supply temperature starts to drop from cold water crossing over
6. Hose bib closed allowing pressure to slowly build up. Verified with P-gauge.

The above figure (Figure 8) shows the data collected from the Pressure Gauge method being tested in Scenario 1, a condition when crossover is present in the test platform system. The graph results confirm that there is crossover in the system. First, the needle on the pressure gauge attached to the hot water subsystem dropped to almost zero as the hot water was being

released through an open fixture, and then slowly increased until reaching equilibrium with the cold water subsystem. In other words, the hot water pressure was reduced, and without adding more hot water to the hot water subsystem, pressure began to rebuild. This means that pressure was allowed to enter the hot water subsystem from somewhere within the test platform system. Since the cold water subsystem still had pressure, it is safe to conclude that the water was crossing over through the mixing valve and re-pressurizing the hot water subsystem. The corresponding data that was gathered by the data acquisition system on the lab test platform is shown by the line labeled "P_WS_H." The line curve matches up with what the research team observed when looking at the needle of the pressure gauge.

As expected, midway through the test, the chart line shows the hot water pressure dropping as a result of an open fixture emptying hot water from the hot water subsystem and then as soon as the research team had closed the fixture, the hot water pressure began to increase to the point where it was before the fixture was opened, as shown by the inclined curve on the chart.

The test data indicates that pressure was released from the hot water subsystem, but because crossover occurred, cold water had infiltrated the hot water system through the defective mixing valve of the opened fixture, thus restoring the lost pressure back to equal levels.

In addition to testing pressure, a temperature sensor was included on the hot water subsystem in order to deny or confirm the pressure sensor data. The chart line labeled "T_WS_H" represents the temperature in the hot water supply, which begins to drop at the time in the testing when cold water enters the hot water subsystem and cools it down.

Scoring positive results under Scenarios 1 & 2, the Pressure Gauge method was verified as an accurate way to detect crossover in a typical multifamily building. Though this distinction should be noted: while the Pressure Gauge method is the best method for detecting crossover's presence in a building, it is not an effective way to pinpoint the problem valve or valves responsible for creating crossover within a building.

3.1.5 Pressure Gauge Method - Discussion

After running through the Pressure Gauge method under scenario 1 & 2, the Pressure Gauge method was verified as an accurate way to detect crossover in a building on the building-wide level. The Pressure Gauge method could not be utilized to pinpoint crossover within a building. The Pressure Gauge method can be implemented quickly. In the case of the test platform the research team was able to conduct a complete test from start to finish within five to ten minutes. The Pressure Gauge method can be taught to contractors with little change of user error.

The most likely area where there could be a false positive would be if the valve used in step 3 of the method did not seal allowing pressure to re-enter the hot water subsystem through that valve as opposed to the water crossing over through a faulty shower valve allowing the hot water subsystem to re-pressurize. Thus, it is important that the user will need to be able to determine if the valve used to cutoff pressure to the hot water subsystem is in working order, and if they do not determine this correctly, then there is a chance of getting a false positive for this method (believing there is crossover when there actually may not be).

This method would be recommended as the quickest way to detect crossover within a building with little potential for user error. It is further recommended that this method be used as an initial screening test to determine if a building has crossover, and if it does, then another method would be used to pinpoint the crossover in order to correct the problem.

3.2 Water Flow Method

3.2.1 Introduction

The Water Flow method was derived from interviews and consultations with multiple sources including a water heater manufacturer (see appendix B) and by reviewing a previously published CEC report. The CEC report presented an overview of the characteristics of crossover and established the way forward to better understanding the science behind crossover. The research team in the CEC report tested the Water Flow method in only in four buildings, none of which showed results of crossover. The authors of that report noted that all the buildings tested were constructed after 1990 and therefore would not provide enough data to draw a definitive conclusion regarding the prevalence of crossover [Lutz 2008].

In the course of the current report, the Enovative research team established that the Water Flow method as a viable detection method. Note: The next phase of this study, managed by Enovative Group, will profile the year the building was built in order to provide further evidence supporting whether or not crossover is more or less prevalent in buildings constructed within a certain time frame, as well as other potential factors such as building size.

The Water Flow method does not require any tools. It is very similar to the Pressure Gauge method in that it there needs to be a working shut-off valve on the water pipe feeding the hot water subsystem. The difference being the indicator for crossover is based on water flow, not water pressure. The water flow method can also be used to pinpoint crossover in a building.

3.2.2 Brief Description

The shut-off valve on the water pipe feeding into the hot water subsystem is closed while the water feeding the cold water subsystem remains open. Water is drained from the hot water pipes by opening a fixture. If crossover is not present, the hot water subsystem will eventually drain and water flow will cease completely. If crossover is occurring, the water flow will continue and eventually turn cold, thus proving the water is coming in from the cold water subsystem.

3.2.3 Detailed Steps for Conducting the Water Flow Method

1. Close the cold water shut-off valve on the cold water supply that feeds into the water heater. Do not close the hot water supply valve nor close the cold water valve found on the main city supply to the building. The purpose of closing the valve on the cold water pipe that runs into the water heater is to isolate the hot water subsystem from its water supply. This valve must be closed completely, otherwise the test method may yield a false positive (i.e. method detects crossover, when there is not crossover).

2. (Optional) If the valves on the hot water subsystem are operational, close any valve around the water heater and storage tank. It is important to note that the Water Flow method requires draining the hot water pipes, and can be conducted more quickly and with less water waste without having to drain the water stored in the tanks.

3. (Optional) If there are additional valves that are available that would further segment the building's hot water subsystem pipes, close and isolate each segment of hot water system pipe and conduct the following steps on each isolated segment. If segmenting the pipes is possible, this allows further pinpointing on which area of the domestic hot water system has crossover.

4. Open a fixture and allow water to drain from the hot water subsystem.
    a. Note: Some methods suggested the use of the fixture at the lowest point, while the research team suggests the use of a fixture at the highest point. Further field testing is required to understand which may be better.
5. Wait for the hot water to drain from the pipes. If there is no crossover, the flow will eventually cease. If there is crossover, the flow will continue indefinitely as the water in the cold water subsystem pushes through a faulty shower valve, and into the hot water subsystem. This continuous flow should turn from hot to cold as the hot water has completely drained and the water flow is made up entirely from the cold water supply. Also, if the flow reduces to a trickle, it may be advisable to open a second fixture to allow air to easily enter into the pipes to displace and help drain the system faster and more smoothly.
6. At this point in the process, if the water flow continues and turns cold, the presence of crossover is confirmed. The next step is to pinpoint the valve or valves where the crossover is occurring. The user would have to go to each fixture and feel the hot and cold pipes, if the hot pipe is colder than ambient air temperature and equal in temperature to the cold water pipe, then that shower valve is causing crossover. Alternatively, it is possible to use a mechanic's stethoscope to hear the water crossing over. The user would be listening to water flow at each mixing point (shower valve, washing machine, etc.…)
    a. If crossover cannot be identified at the fixture's mixing valve, it can indicate there is a direct cross-connection whereby a cold water pipe is connected directly to a hot water pipe.

3.2.4 Water Flow Method – Results

The following table summarizes the results of testing the Water Flow method of crossover detection.

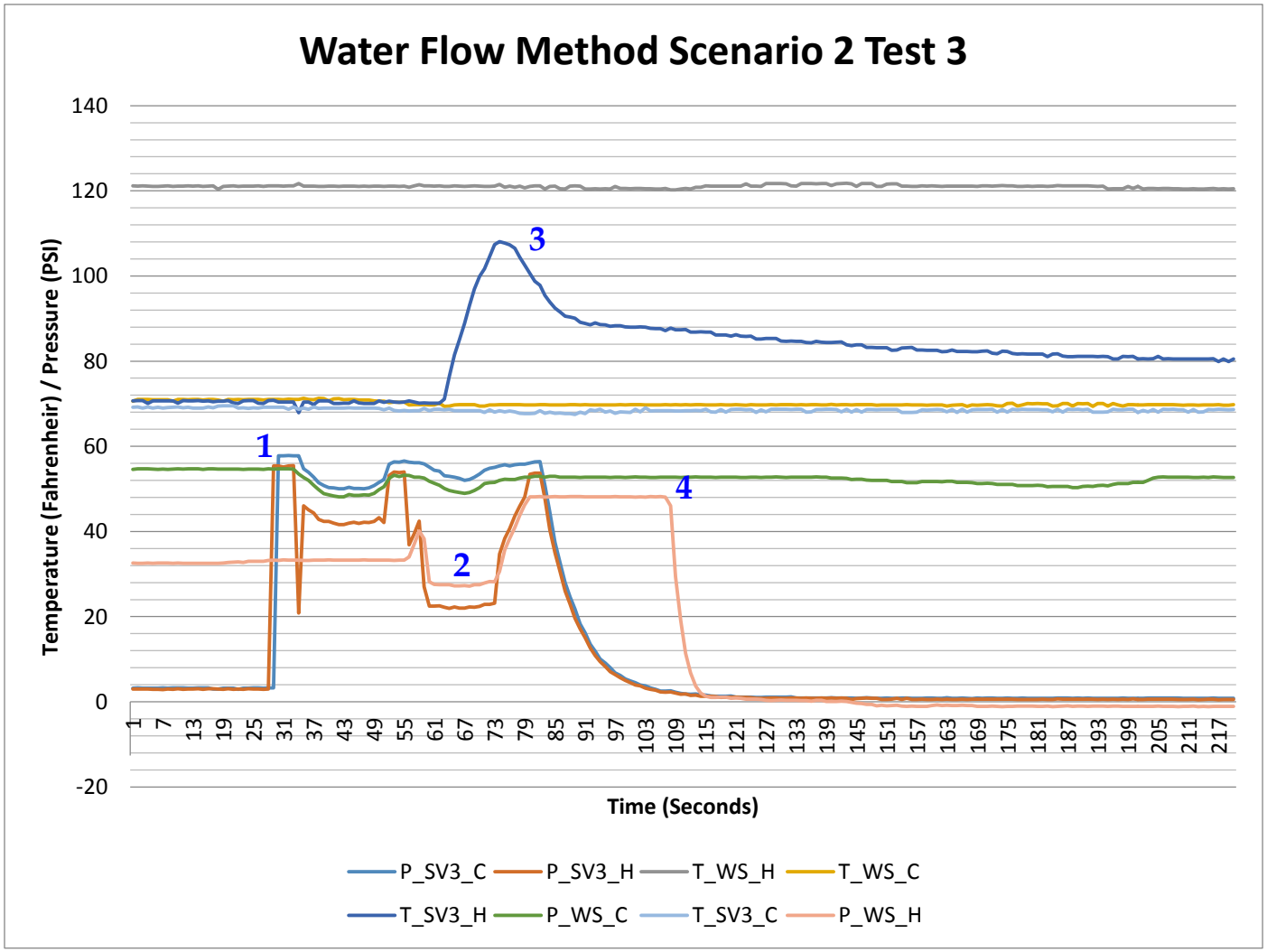
Table 6: Water Flow Method Verification Results

Water Flow Method Results Summary	
Test Platform Setup:	Results:
Scenario 1 (with crossover)	Crossover Detected
Scenario 2 (without crossover)	Crossover Not Detected
Water Flow method - Verified	

The above results from the test platform verify that the Water Flow method is a reliable method for detecting crossover and, with extra precaution, is unlikely to result in false positives (i.e. detecting crossover when it actually is not there).

The test results were supported by the logged data. Figures 9 and 10 show the Water Flow method being tested under each scenario.

Figure 9: Water Flow Method Scenario 2 Data



Annotations for the chart above:

1. Cold water facet opened at SV3 to ensure the entire line is filled with cold water from WS and left open
2. Hot water faucet was opened at SV3 to ensure that the entire line contains only hot water from heater and then closed
3. Hot water valve and fixture at SV3 opened to heat it up.
4. Hose bib opened by the pump at the return line while all other how water lines were closed. Pressure drops indicating absence of cross over as all the hot water is drained.

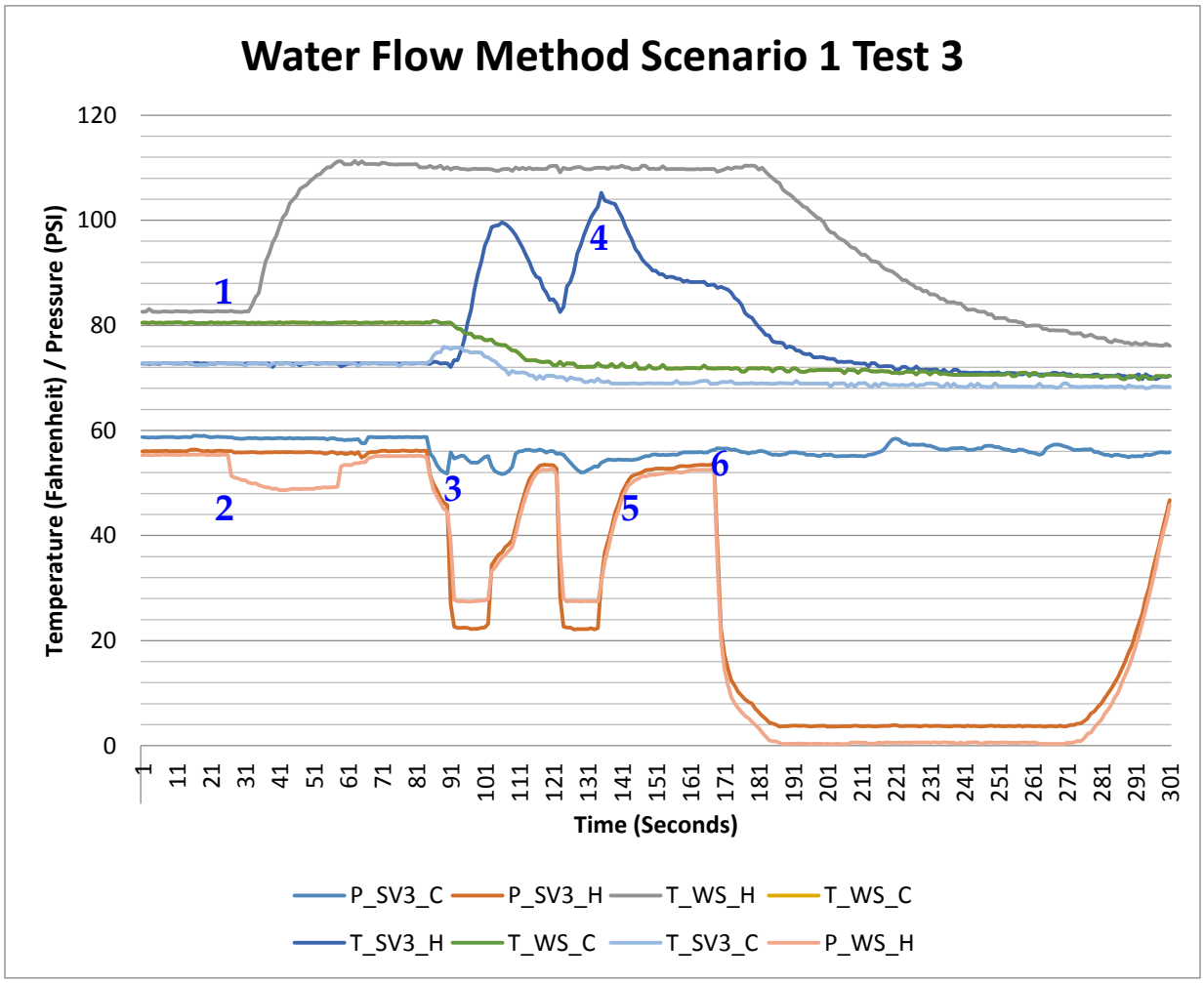
The figure shown on the pervious page (Figure 9) shows the water flow method being tested on the test platform with the Scenario 2 treatment, a situation without crossover in the system.

The data shown by the line labeled "P_WS_H" represents the pressure of the hot water subsystem. This line illustrates the expected response that a user of the Water Flow method would experience when there is no crossover in the system.

As the research team drained the hot water subsystem, the line shows the water pressure steadily decreasing to zero and never re-pressurizing. The water pressure reading has enough correlation with the water flow to establish reliable data, and is similar to the Pressure Gauge method, with the only difference being the use of pressure or flow to indicate crossover or not.

As the chart shows about midway through the test, the water pressure dips down and by the end of the test; the line had dropped and remained at zero pressure. This indicates that the water was drained from the hot water subsystem, and since there was no crossover, and thus no other source of water for the hot water pipes, the pressure could not rebuild.

Figure 10: Water Flow Method Scenario 1 Test 3 Data



Annotation for the chart shown on the pervious page:

1. Closed all valves to isolate SV3 and the recirculation valve was opened to heat up the Hot water lines
2. Pump unplugged and hot water line at SV3 opened and to heat it up.
3. Cold water at SV3 opened to cool the cold water line to cool it down..
4. The spike indicates the SV hot water line open again for redundancy.
5. All other valves except the SV3 loop were closed.
6. Hose bib opened to let all the water run.
7. The pressure rises back due to cross over existence since the cold water enters the hot water line at SV3 and continues to flow through.

The figure shown on the previous page (Figure 10) shows the Water Flow method being tested on the test platform with the Scenario 1 treatment, with crossover in the system.

In the test platform, the corresponding data that was gathered by the data acquisition system is shown by the line labeled "P_WS_H." The chart line correlates with the water flow, as recordable water meters were not available at the time of the data being captured.

At midway through the test, the chart shows the water pressure begins to decline from opening a fixture. Then, towards the end of the test, when the research team had closed the fixture the pressure line starts to climb back up to the point where it was before the fixture was opened. This is a similar result to the Pressure Gauge method, because the two methods are very similar in concept. In this case, the method would diagnose that there is crossover when water flow continues after the hot water valve has been closed and is eventually fed by cold water.

All the temperature points support the pressure data. The temperature of the hot side of the shower valve "T_SV3_H" is heated up and then once the water flow method has begun attempting to drain the hot water pipes, cold water crosses over into the hot water pipes and cools down the "T_SV3_H" data point to the degree where it is equal in temperature to the temperatures in the cold pipes "T_WS_C, and T_SV3_C." Since this is a fixture known to have crossover, the data matches and confirms step 6 of the water flow method whereby the faulty mixing valve is located when the hot side and the cold side of the pipes are equal to the temperature of the cold water.

Furthermore, as the test continues to run, the chart shows the temperature of the hot water supply "T_WS_H" becoming colder as more and more cold water intrudes into the hot water subsystem.

3.2.5 Water Flow Method – A Field Test

The research team was able to test the method at a live field site that had experienced some symptoms of crossover. In this case, the research team was notified of a building and arrived at a time when a recirculation pump was being replaced. The water supply to the hot water subsystem had been closed and the recirculation pump removed from the return line. When the return line valve was opened, water emptied out of the pipe where the recirculation pump had been installed. The recirculation pump was located on the roof, which avoided having to drain

the entire hot water distribution system. In order for the Water Flow method to work properly, only the section of pipes on the roof would need to be drained.

Note: The field test revealed that the water flow test may work better by draining water from a high point in the hot water subsystem as opposed to a low point, which was specified during the industry interviews. This discovery is significant and will be fully explained in the Discussion section. During the test, water continued to flow from the opening and eventually turned cold (although the hot water storage tank was still hot).

3.2.6 Water Flow Method – Discussion

After testing the Water Flow method under Scenario 1 & 2, the water flow method was verified as an accurate way to detect crossover in a building and it provides the user with a way to pinpoint crossover. While testing the method, the research team observed potential issues unique to conducting this method, some of which are easily solved.

One observation was that due to the fact that a hot water distribution system works in the same way surface tension acts in a straw filled with water (i.e. when the top of a straw is plugged and lifted out water, and the water stays in the straw seemingly defying gravity) whereby water has trouble escaping the system due to the inability for air to come in and displace the water. This would typically only be a concern where there is not crossover, as in a system with crossover the intruding cold water would displace the hot water, allowing the hot water to come out and be drained. This is problematic because in this case the water goes down to a trickle and the user of the water flow method could potentially mistake this to be the water flow stopping. To guard against this, the user must realize that the water that has flowed out of the system does not equal the volume of water contained within the system. Furthermore the user can open another fixture, allowing air to come in and displace the water.

Another observation from testing this method is that the amount of time that is required to drain the hot water pipes will vary upon the building and volume of water in the pipes, which is also affected by the first observation above regarding surface tension, "*the straw effect*." This is problematic because it requires the user's judgment to determine whether or not the level of water flow is due to the building taking a long time to drain or whether it is crossover. The temperature of the water flow helps make a distinction, but it still leaves some potential for false positives and false negatives when the user makes an error or does not fully understand the concepts of this method.

Draining the entire hot water subsystem may take a long time and would generally waste a significant amount of water. Furthermore, the draining of the hot water system, and subsequent re-filling of the hot water pipe when the test is finished introduces the probability of creating more problems within the water heating system than there was to begin with. If the air that is added to the system by using Water Flow method is not properly purged, damage to the shower valve cartridge can occur. *Thus, the testing for the presence of crossover may inadvertently ruin a shower valve cartridge and create the conditions for crossover where it had not been.*

Finally, the Water Flow method requires a lot of water, because the user has to drain the water from the pipes. This can be water wasteful.

The research team was able to take this method, gathered from industry expert interviews, and then further refine the method based on solving problems raised with the observations above.

1. Since this method required draining the hot water pipes, valve off water heater to avoid having to drain the water heater tank.
2. Drain from a high point instead of a low point to save time and water.
3. Open second point for air to enter the hot water distribution system and displace the water to speed up the draining of the hot water subsystem.
4. Segment sections of building to test a portion of a building.

These refinements can speed up the process of using this method, reduce water waste, and the potential for user error. These refinements were included above in the detailed steps to conducting the Water Flow method.

3.3 Eatherton Method

3.3.1 Introduction

The Eatherton method is named after a plumbing engineer who developed and published the procedure (Appendix B). The research team found his method online, mentioned in various plumbing industry forums. The research team also spoke directly with the engineer during the interview phase of the report. The Eatherton method requires no tools to perform, and does not cause any interruptions to water service in the building like the Pressure Gauge or Water Flow methods.

When it was tested on the test platform, the method was shown to produce valid results. It is a method that involves testing one fixture for crossover at a time. This makes it the preferred method for pinpointing the exact fixture responsible for crossover, once the presence of crossover in a building has been confirmed.

3.3.2 Brief Description

To execute the Eatherton method, a suspected shower valve is heated by turning on hot water and waiting for the hot water to arrive. When the valve is at its hottest, the shower valve is turned off, and a nearby fixture, such as a faucet is turned on to the hot water position. While this happens, the user pays attention to any changes in heat on the shower valve. If the temperature drops rapidly, then the presence of crossover is likely. If the shower valve retains its heat, then it does not have crossover.

3.3.3 Detailed Steps for Conducting the Eatherton Method

1. Go to the apartment unit with fluctuating temperatures or low to no hot water.
2. Remove the shower valve handle and face plate cover. [pic of faceplate removed]
3. Turn on the shower valve to the hot position until the hottest possible water flows from this valve. The purpose is to heat the shower valve with the hot water flow.
4. Turn off the hot water once the shower valve is at maximum temperature.
5. Turn on a nearby fixture to the hot position, like a lavatory faucet. The purpose is to cause the water to cross over at the shower valve, if the valve is faulty. By opening a nearby fixture, it can potentially trigger the crossover by pulling water through the shower valve.

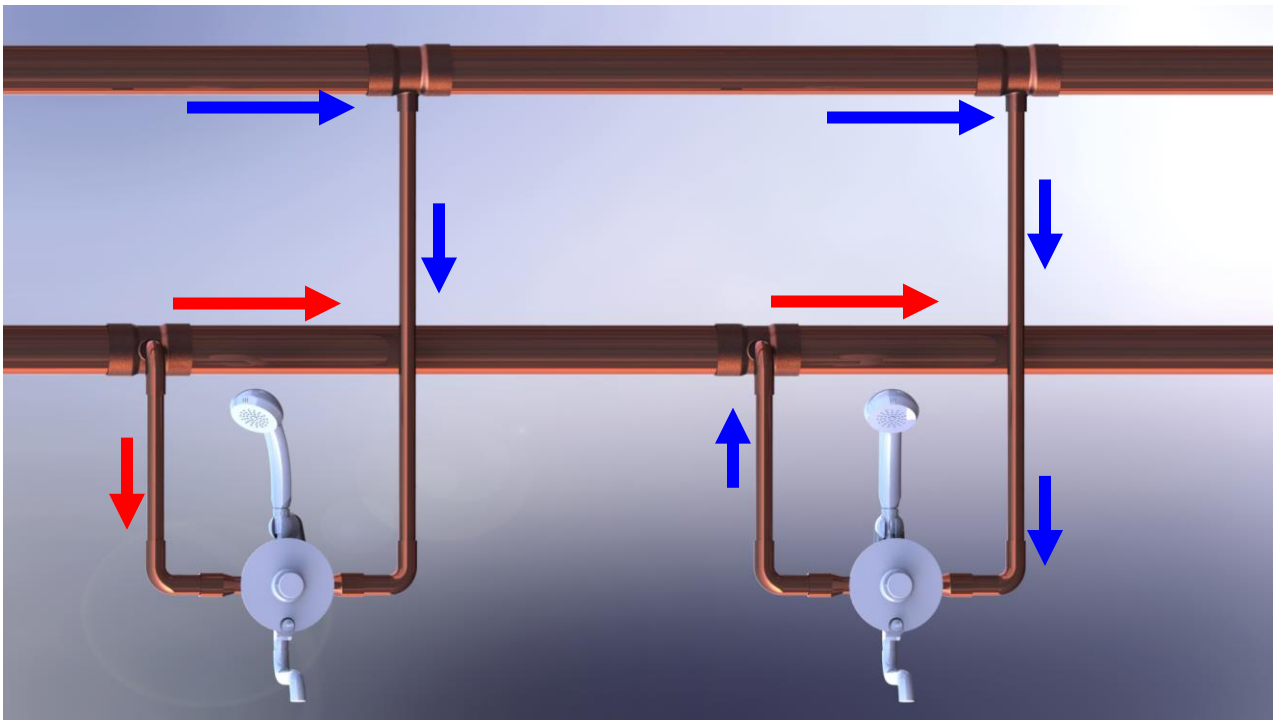
6. Feel the shower valve. If the shower valve retains its heat, then the water is not crossing over. If the valve cools down rapidly, then cold water is leaking through the shower valve and is an indication of crossover.

    a. In the case of pressure balance shower valves, to confirm crossover, close a shut-off valve on one side of the cartridge using a screwdriver.

       Turn on the shower valve, and if water flows, then the cartridge is bad and allowing crossover. If water does not flow, then the cartridge is okay.

A potential modification to this method would be to close the valve on the cold water supply to the water heater. This would create a more direct flow from a faulty fixture crossing over to the nearby fixture.

Figure 11: Eatherton Method Crossover Flow Pathway



Another alteration would be to turn off any recirculation pump in the system, which might allow the crossover to arrive at the nearby fixture as cold water. If a recirculation pump is running it may dilute the cold water crossing over and so the nearby fixture would continue to provide hot water, thus masking the presence of a faulty mixing valve.

3.3.4 Eatherton Method — Results

Table 7 on the following page summarizes the results of testing the Eatherton method of crossover detection.

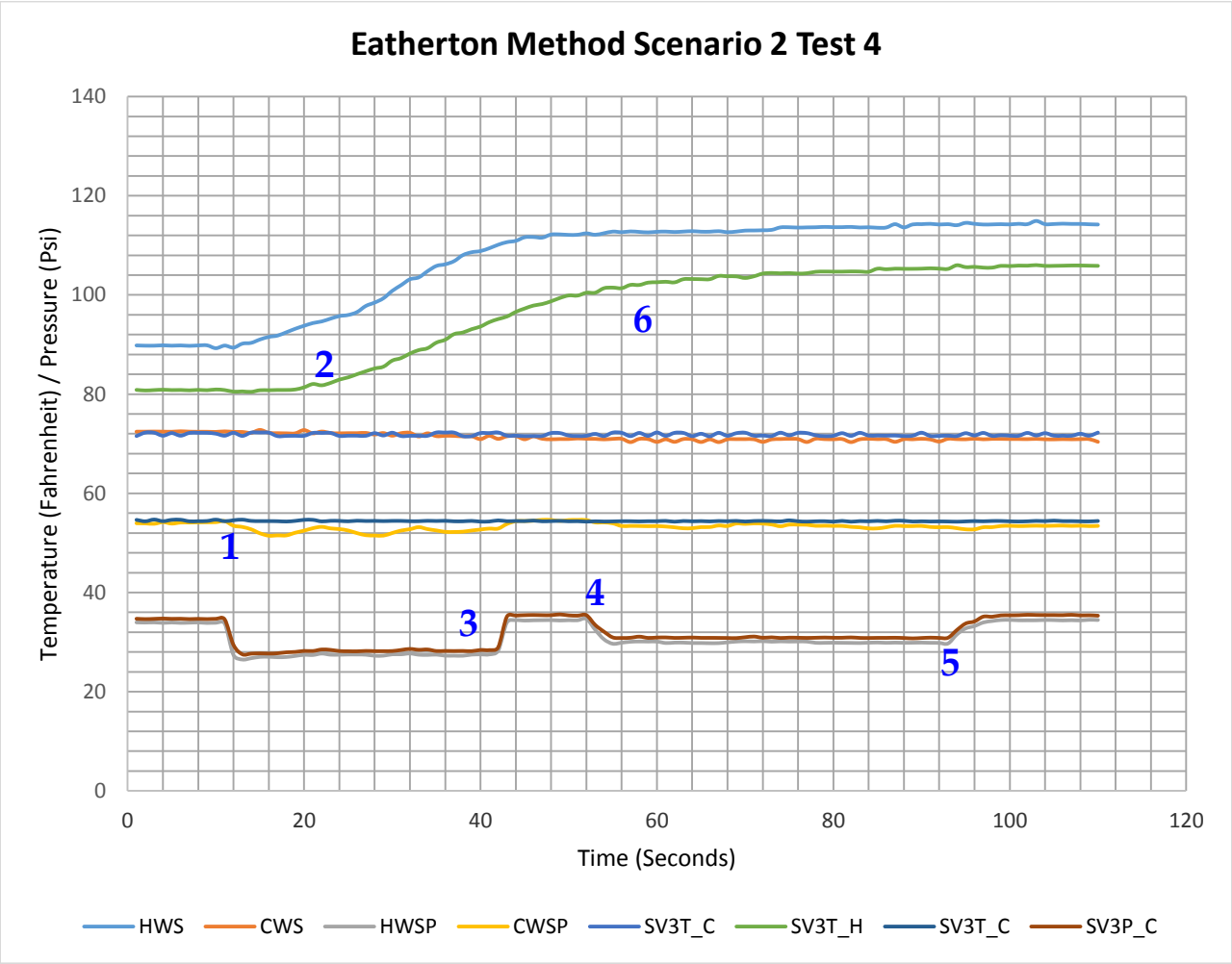
Table 7: Eatherton Method Verification Results

Eatherton Method Results Summary	
Test Platform Setup:	Results:
Scenario 1 (with crossover)	Crossover Detected
Scenario 2 (without crossover)	Crossover Not Detected
Eatherton Method — Verified	

The above test results have verified that the Eatherton method is a reliable method for detecting crossover that is unlikely to result in false positives (i.e. detecting crossover when it actually is not there).

The results are further supported by the logged data. Figures 12 and 13 45 show the Eatherton method being tested under each scenario.

Figure 12: Eatherton Method Scenario 2 Data



Annotations from the chart on the previous page:

1. SV3 opened causing pressure drop in.
2. Shower Valve 3 hot temperature rises.
3. SV3 closed, regaining pressure
4. Shower Valve 2 is opened causing a smaller drop in pressure at SV3.
5. Shower Valve 2 closed
6. Temperature rises from step 11 and stays consistent regardless of shower valve 2 usage.

Figure 12 shows the Eatherton method being tested on the test platform with the Scenario 2 treatment, without crossover in the system.

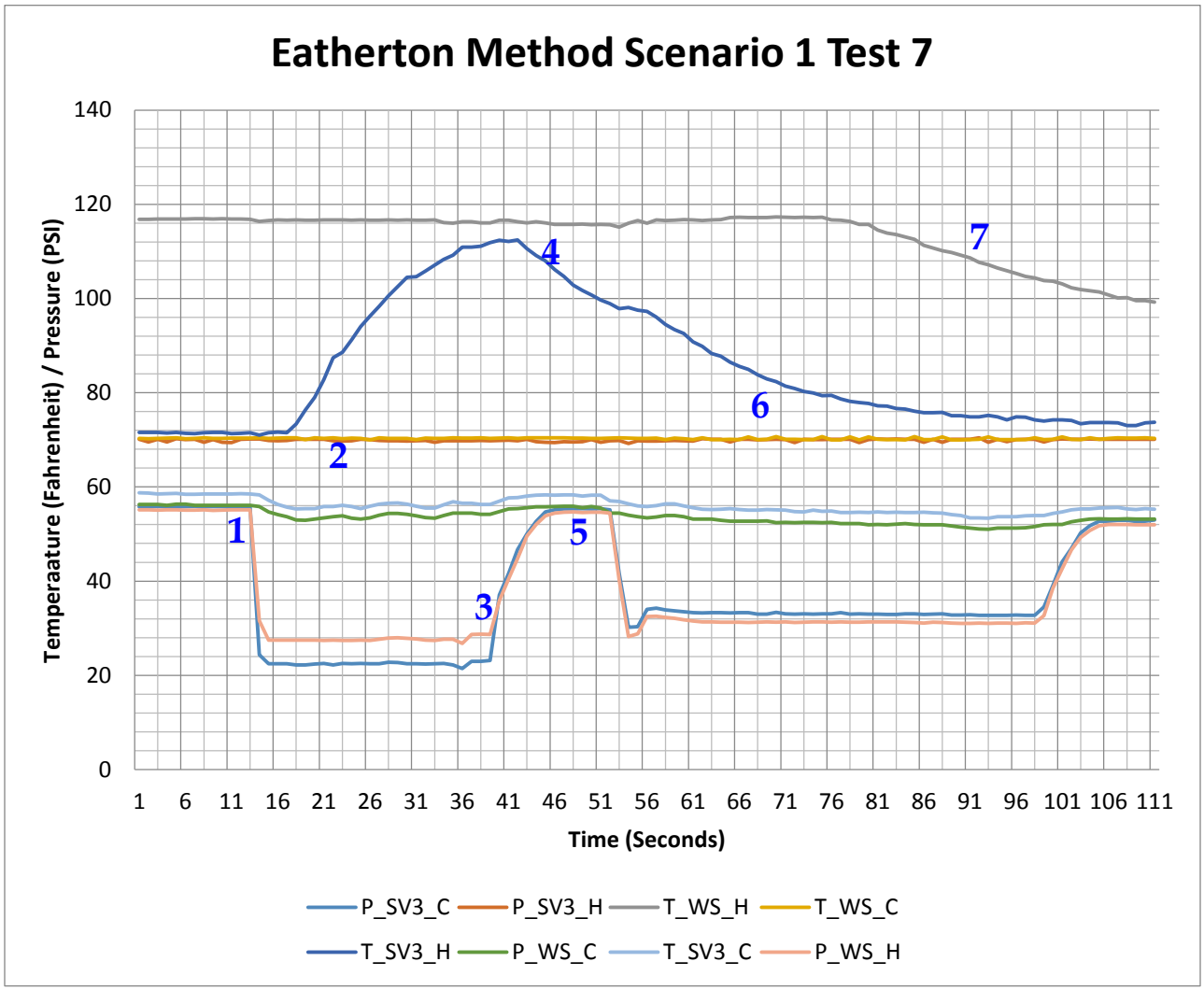
In the field, the result that the user will see that indicates there is crossover, is that the temperature of a suspected shower valve retains its heat (after being heated), when a nearby fixture is opened.

This means that water is not crossing over through the suspected valve, because if it were, then cold water would be flowing paste the suspect shower valve and thus the valve body of the shower valve would cool down rapidly. If the valve retains it's heat it means there is no cold water crossing through it, and thus no crossover.

In the test platform, the corresponding data that was gathered by the data acquisition system on the lab test platform is shown by the line labeled "P_WS_H" or the temperature on the hot side of the valve, closest to the valve. The chart line correlates with what the user of the method would feel when they are checking the temperature of the shower mixing valve.

The temperature reading stays steady when the nearby fixture is opened, and so the method is diagnosing that there is no crossover occurring. Since this is scenario 2, the method thus far is showing that it would not yield a false positive.

Figure 13: Eatherton Method Scenario 1 Test 7 Data



Annotations from the chart shown above:

1. Sv3 opened causing pressure drop
2. SV3 temperature rises
3. Sv3 closed regaining pressure
4. Cold water starts to crossover into the hot side of SV3
5. Shower valve 2 is opened causing a small drop in Sv3 pressure
6. Crossover continues to occur bringing Sv3_H temperatures to about 70°F
7. HWS cools to about 20°F

The figure shown above (figure 13) shows the pressure gauge method being tested on the test platform with the Scenario 1 treatment, with crossover in the system.

In the field, the result that the user will see that indicates there is crossover, is that the shower valve body will cool down rapidly when a nearby fixture is opened up. This means that the cold water is crossing through the valve and into the hot water lines and is thus cooling down the shower valve body.

In the test platform, the corresponding data that was gathered by the data acquisition system on the lab test platform is shown by the line labeled "T_SV3_H" which is the temperature right next to the shower valve body on the hot side of the valve. This chart line matches with what the user of the method would feel when attempting to conduct this method of crossover detection.

On the chart, the T_SV3_H line is showing a rise in temperature as the suspected mixing valve is being heated. At the same time, the pressure data shows a corresponding drop in pressure. Once the valve is hot, reaching a peak of approximately 115 degrees F, a nearby fixture is opened and the temperature, as indicated on the chart, immediately begins to decrease to within a few degrees of the cold water pipes.

This means that the shower mixing valve is faulty and is causing cold water to cross through it into the hot water subsystem. Thus the method is correctly diagnosing the system to have crossover. Since this is Scenario 1, this matches with expectations and this method is therefore verified.

3.3.5 Eatherton Method – Discussion

The Eatherton method showed crossover in scenario 1 and no crossover in scenario 2, and is therefore a valid method for detecting crossover.

An important benefit to using this method it that is doesn't require interrupting hot water service to an entire building as opposed to the Water Flow method which will shut off hot water service for up to 30minutes or more. The Pressure Gauge method also interrupts hot water service, but only for a few minutes.

Another benefit, and probably the most important benefit, is the Eatherton method provides a way to detect crossover at the fixture level. This is useful for identifying fixtures that allow crossover, and thus pinpointing crossover within a building. The drawback to the Eatherton method is while it can be the most effective detection for specific fixtures it cannot be used to detect crossover at a building-wide level. Therefore to test a whole building would potentially require testing every fixture in the building. This can be minimized by the starting at points in the building that have hot water issues that match the symptoms of crossover such as fluctuating water temperatures.

The caveat to using this method is that there is a higher probability for user error because it requires the user's judgment to decide what it means for the valve to cool down rapidly. The experience of "rapidly" can vary from person to person. Also, there will be natural radiation of heat from the valve into the surrounding air, and although the influence is slight, there may be a case where it seems as if the valve is cooling down due to crossover, when it is in fact it has been cooled by the air. While the research team acknowledges that a professional plumber with years of experience is unlikely to make an error of judgment, it is worth pointing out potential pitfalls.

Another possible flaw to consider is that the Eatherton method would not be able to detect trace flows of crossover. In other words, if only small amounts of cold water are crossing over through the mixing valve, it might not change the temperature enough in the shower valve to noticed by the user

Finally, the other possible problem with using the Eatherton method is that it assumes the nearby lavatory fixture shares the same hot water branch that is feeding both the suspected faulty shower valve and the nearby fixture, which would create the environment whereby crossover can occur. The opening of the nearby fixture causes a pressure drop in the hot water lines, and the makeup water's path of least resistance may be from a cold water line connected to the faulty shower valve. This is another hypothetical problem that could not be verified on the test platform. Further field research may shed additional light on these hypotheses.

The research team recommends this method be used in situations where pinpointing faulty fixtures is needed and when it not feasible or not allowed to conduct more intrusive methods to pinpoint such fixtures such as the Water Flow method.

3.4 Temperature Differential Method

3.4.1 Introduction

The temperature differential method derived from interviews with boiler controller manufacturers and boiler installation contractors.

The Temperature Differential method requires the use of logged temperature data over several days, whereby the temperature data being tracked is on the hot water supply pipe to the building and on the hot water return line from the building. An alternate approach uses temperature data on the hot water return line, but for each interval at which the temperature is recorded (e.g. 30 minute interval), the temperature is recorded as a minimum, average and maximum. The method also requires continuous recirculation of the recirculation pump and therefore a recirculation loop must be in place. It also requires normal water usage by building occupants. For that reason, this method was not implemented on the Test Platform, as the test platform could not simulate occupant usage.

3.4.2 Brief Description

The Temperature Differential method involves tracking the temperature of the hot water supply and hot water return and logging the data. The data is then analyzed for patterns that could be the result of crossover.

One pattern that indicates crossover would be a temperature differential between the hot water supply (HWS) and hot water return (HWR) that is greater than it should be, even if the recirculation pump is running continuously. For example, if the hot water supply temperature is 140 degrees F, while the return line is 135 degrees F the system is behaving normally. If the hot water supply is 140 degrees F, and the hot water return is closer to 100 degrees F the system might have crossover.

An alternate pattern could occur when comparing the temperature minimums of the return line for each period and comparing the readings to the temperature averages for the same intervals and seeing if the temperature minimums hit much lower numbers than the temperature averages. If crossover is present in the system, then the HWR minimums will be far lower than the HWR averages for the same time period.

3.4.3 Detailed Steps for Conducting the Temperature Differential Method

1. Attach temperature sensors to the hot water supply a few feet downstream of any hot water storage tank and to the hot water return, a few feet upstream of any hot water storage. The temperature sensors should be connected to a data logger that can record at intervals of at maximum 30 minutes. The data logger should also be able to record minimums for the intervals, averages, and maximums.
2. Confirm that the recirculation pump is running continuously.
3. Log the temperature data for several days under normal use.
4. Analyze the logged data.
    a. If the logged data shows a larger than normal temperature differential between the hot water supply and the hot water return, or between the minimums for the hot water return and the averages for the hot water return, then there may be crossover. If there is a normal differential, then there is no crossover.

    Note: The research team was not able to determine what a normal and an abnormal differential would be. There are ways to do engineering calculations to determine what should be normal, but it requires information that is difficult to obtain for existing building stock and is out of reach for the typical user which is typically going to be a plumbing contractor.

3.4.4 Temperature Differential – Results

This method could not be implemented on the test platform because it requires building occupants and normal usage over an extended amount of time. These conditions were not suitable to the test platform design.

3.4.5 Temperature Differential – Discussion

The temperature differential method could not be tested on the lab test platform and therefore could not be validated as a method for detecting crossover.

Based on the interviews, the research team would recommend that this be considered indicative of crossover, but not conclusive of crossover.

Furthermore, this method cannot be tested in a single day, which would be impractical in most situations and also requires tools not typically in possession of the intended typical user of these methods, which would be plumbing contractors. Although, temperature sensors and data loggers are a typical tool for an energy professional who could also find utilization of the methods for detecting crossover profiled in this report.

3.5 Pump Control Method

3.5.1 Introduction

The pump control method involves turning off circulation to the hot water loop or installing a temperature-based control on the pump to turn on and off the pump.

The research team decided to discard this as a method without testing for reasons stated in the following discussion.

3.5.2 Pump Control Method — Results

There are no test results, as this method could logically be discarded for reasons discussed in the following section. This method could not be implemented on the Test Platform as it required building occupants and normal usage that can only be found in a real multifamily building that is occupied.

3.5.3 Pump Control Method — Discussion

The pump control method was discarded early in the review process for the following reasons.

- A pump that is turned off, and subsequently causes a complaint in hot water service cannot confirm or deny crossover. If there is crossover, it may unmask or cause similar symptoms, but it cannot be used as a detection method that gives the user likely confirmation that a building does or does not have crossover.
- Turning off a pump can cause a complaint by itself, without any crossover, therefore it would show a false positive.
- When no complaint arises, that cannot confirm that there is no crossover, and thus yield a false negative. There are small buildings where the recirculation pump burns out, and it does not cause enough of a problem to yield a complaint.

Based on these reasons, the research team rejected and discarded this method as a valid method for detecting crossover. Even so, there is some utilization of these findings, as it provides a way to make buildings with crossover convert from being asymptomatic to symptomatic. With genuine symptoms at play, further investigation using one of the valid methods can then confirm or deny whether or not crossover is present in the buildings.

Entering a building where there are aqua-static or other temperature based controls for the recirculation pump that are bypassed or disconnected, may indicate that crossover was the culprit to such controls being bypassed or disconnected.

3.6 Water Meter Method

3.6.1 Introduction

The Water Meter method was developed via an interview with an onsite maintenance staff member for a multifamily garden style building in Santa Ana, California. This building had a central DHW system, and each dwelling unit had submeters on the hot water and cold water being fed to the unit. In the past, the water submeters had been used to bill the tenants for hot and cold water, which typically is paid for by the building owner.

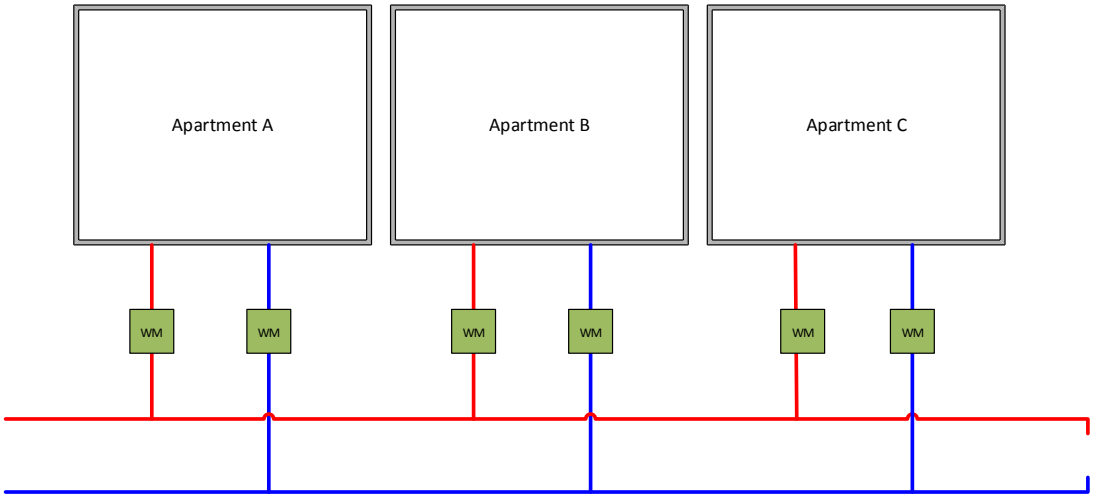
The maintenance man reported that occasionally he would see the submeters spinning backwards and when he changed the shower valve cartridge that the spinning would stop.

The research team walked throughout the property to see other instances of the meters spinning backwards. The research team observed that when the hot water meter was spinning slowly backwards, that the cold water meter was spinning forwards, and there was no one in that particular unit. This meant nearby usage of other units or even the recirculation pump was causing crossover in the units with faulty shower valves.

3.6.2 Brief Description

The Water Meter method requires that each unit's hot and cold water lines have water submeters on them.

Figure 14: Submeters on Each Dwelling Unit



Water Meters sub-metering hot and cold water for each apartment

This is in a subset of existing building stock as it is not a common construction method. Furthermore, it requires the recirculation pump or a nearby unit to be drawing hot water. The actual suspected unit does not use any water during the test.

The user of this method would take note of the needles on the water submeters, and observe the change in position of the needles over the course of one to five minutes. If the needle shows that one of the meters is spinning backwards while the other meter is spinning forward, then crossover is occurring (e.g. the needle was initially at the number 4 on it's dial, and then 2 minutes later it read 3, without making a full revolution i.e. needle going backwards). If there is not movement, then there is no crossover.

3.6.3 Detailed Steps for Conducting the Water Meter Method

The research team created these steps.

1. Confirm that the units in the building have separate hot and cold lines that are submetered and that the building uses a central domestic hot water system. In other words, this method will not work in a building that is submetered, but has individual water heaters in each unit.

2. Confirm that a recirculation is operating and turn on a hot water fixture at a nearby source outside of the unit that is being tested.

3. Take note, or mark down the position of the water meter needles. If there are multiple indexes (dials with numbers), the user should take note of the indexes that signifies the lowest volume of water flow such as "x0.1" versus "x1" which means for every revolution that 0.1 gallons has flowed past the meter.
4. Observe the needles for at least one minute. Observe the needle the entire time, as the user needs determine which direction the needle moved (clockwise or counterclockwise), if the needle moves off the noted point in step 3.
5. If the needles moved, and moved backwards from the number noted in step 3, to a lower number, then there is crossover. If the needles remained in their position then there is not crossover.

3.6.4 Water Meter Method – Results

This method could not be verified under the typical verification plan used on the other method, but the research team was able to establish a custom verification plan that would confirm that the method worked.

The research team went to the field location where they had interviewed a maintenance person who provided the foundation for this method. Identified a unit that had the spinning meters, using the detailed steps described above. Removed the shower cartridge and replaced it with a new one. After the replacement was complete, the meters stopped spinning. This supported the theory.

The research team then inserted the shower valve taken from that site in the test platform. Then observed on the faulty shower cartridge behaved on the controlled test platform. The research team observed that the valve had crossover by observing the uni-directional flow meter showing crossover flow through the valve. The valve was also heated and temperature sensors corroborated that the cold water was crossing through it to cool it down (in essence the Eatherton method).

After pressure, flow, and temperature data corroborated that the shower valve cartridge taken out of the site was one that allowed crossover, the research team confirms that there was crossover at the field location the shower valve cartridge was taken out of and therefore the Water Meter method is a valid method for detecting crossover.

3.6.5 Water Meter Method – Discussion

The Water Meter method was verified via a custom pathway to be a valid method for detecting crossover.

It requires that a building be setup in a particular way, which means the method would not apply to a majority of building sites. It requires that each unit be submetered, and have a central domestic hot water system. It is generally impractical and probably unfeasible to add this equipment to buildings if it is not constructed in this fashion from the beginning.

But the research team suggests that this way of construction has been gaining more popularity in recent years due to rising costs of water. This construction method allows the building owner to shift the burden of these utilities to the tenants. The typical building owner that would construct a building in this fashion would be a building owner who is very conscious of utility costs, and who is going to continue to own the building after it's built for many years, which

would incentivize them to look at optimizing the operating cost of the building even if it raised initial construction expenses.

Since the use of this method is narrow in scope, the research team does not recommend this method be used. It works, but is impractical.

CHAPTER 4:
Discussion, Conclusion, Recommendations

4.1 Results from Testing Detection Methods

The following table summarizes the results from testing the crossover detection methods.

Table 8: Summary Results from Verification of Methods for Detecting Crossover

Method	Scenario 1 Result	Scenario 2 Result	Verification	Notes
Pressure Gauge Method	Detected	Not Detected	Method Validated	Quickest, building-level test
Water Flow Method	Detected	Not Detected	Method Validated	Building-level and pinpointing detection possible
Eatherton Method	Detected	Not Detected	Method Validated	Pinpointing detection possible, non-invasive
Temperature Differential Method	N/A	N/A	Invalid	Can be indicative of crossover
Pump Control Method	N/A	N/A	Invalid	Discarded, but may reveal crossover symptoms
Water Meter Method	Detected	Not Detected	Method Validated	Only possible in some buildings

4.2 Discussion of Results from Testing Detection Methods

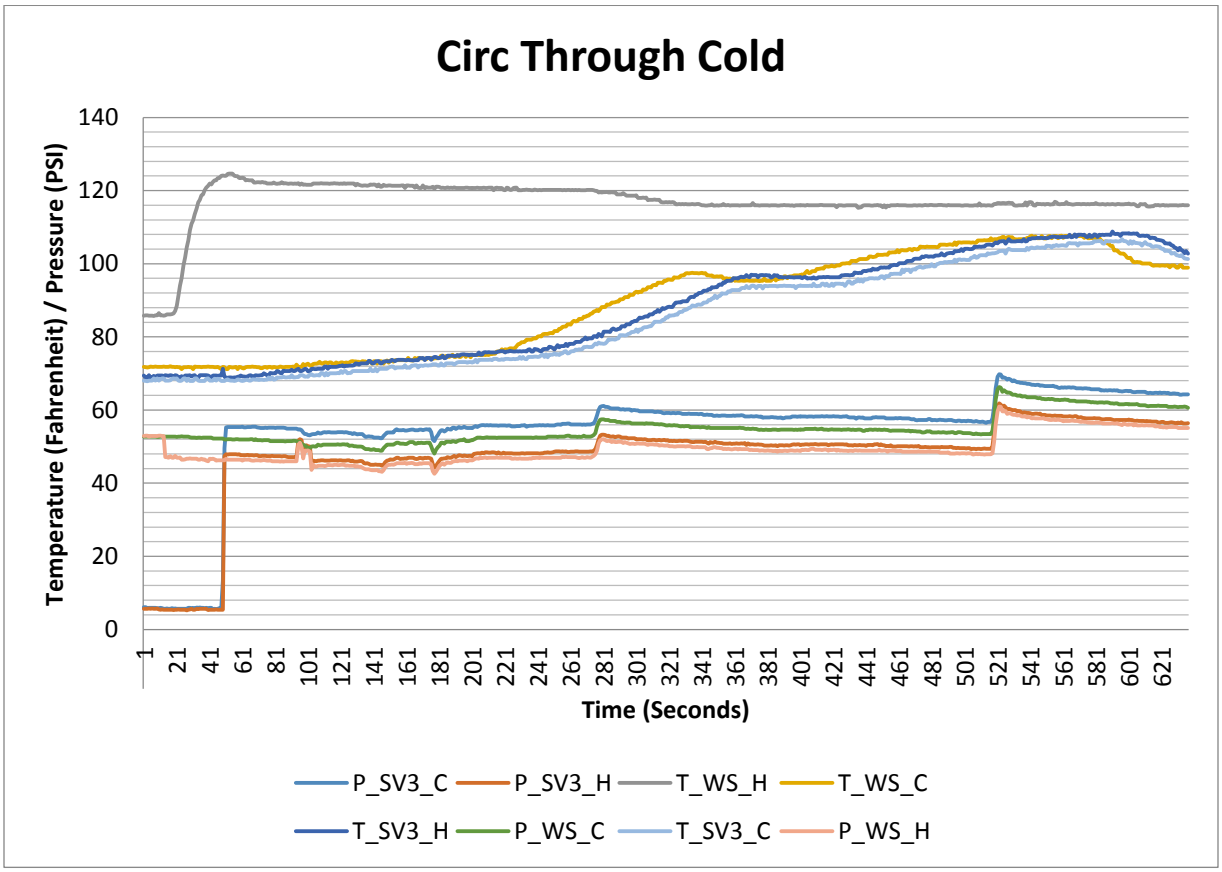
This report validates multiple methods for detecting crossover, and discards other methods that were not consistent or practical. Each of the validated methods have their pros and cons and can be utilized in combination with one another to more efficiently and conclusively determine if a building has crossover, and then pinpoint the crossover within the building.

It should be noted, during the course of the testing, the research team identified an anomaly that has a direct effect on energy usage of domestic hot water that comes from crossover as well as a negative effect on the tenant's hot water experience.

The anomaly was discovered during a Scenario 1 (with crossover) test, while the recirculation pump was running. The research team noticed that crossover was occurring through the faulty mixing valve, and that the pump was using the cold water lines and the hot water lines to continue circulating throughout the system. This was further supported by data that showed when the speed of the pump was changed that the flow rate of the crossover also changed and correlated with the increases and decreases of the speed of the pump.

The data on the following page (Figure 15) shows the pressures and temperatures each taking a step up, as the pump speed was changed from low speed, to medium speed, and finally to high speed.

Figure 15: Circulation Anomaly Data



After approximately ten minutes, all the cold water lines were hot, as shown in figures 16, 17, and 18 from the thermal imaging camera.

Figure 16: Faulty Shower Valve Before Recirculation Pump is Turned On. Both Hot and Cold Line are ambient and equal in temperature

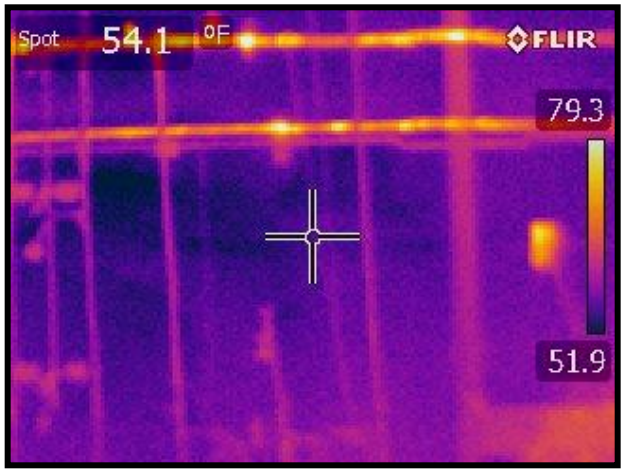


Figure 17: Faulty Valve Allowing Crossover from Recirculation Pump Flows and Eventually Heating up

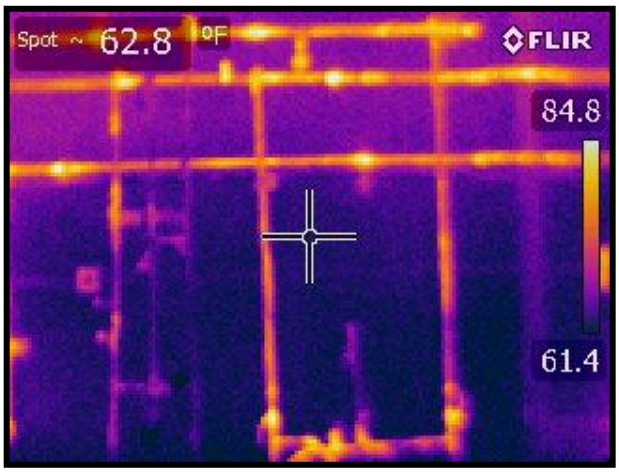


Figure 18:Photo Showing All Water Lines Are Hot, Including Cold Water Lines Because the Shower Valve is Allowing Crossover

This data supports the idea that the recirculation pump will take advantage of a faulty mixing valve, and exploit these weak spots within the system to create additional pathways of water circulation, which in essence, creates multiple recirculation loops between the cold water and hot water subsystems. This leads to a corruption of the domestic hot water system and the unintended annihilation of all energy efficiency efforts.

This has a direct impact on energy consumption because heat is mixed with water from the cold water subsystem, as well as both cold and hot water pipes become hot, and so there is more surface area for heat to radiate and be lost into the surrounding air. This is known to increase energy waste in a hot water distribution system [Lutz 2008].

Aside from identifying this anomaly, the results of this phase of the study have developed the required baseline science to further investigate crossover. In order to study a problem, a way to detect and identify the problem must be established and that is what was accomplished with this report.

Furthermore, the research team believes that studying crossover in the field is an important pathway to revealing the full extent of the problem. If crossover turns out to be more pervasive than previously imagined, then there is a significant amount of energy savings to be captured.

4.3 Recommendations

Upon completion and submission of this report to the California Energy Commission, the research team at Enovative Group will follow through with a video archive of the tests as they were conducted at the test platform and a concise instruction manual standardizing the step by step process of each verified method as well as how to apply different methods to achieve the most accurate detection of crossover. This effort to circulate the information quickly and effectively will be combined with an ongoing series of lectures and demonstrations to industry professionals to raise awareness and concern about crossover.

Based on the conclusions of this report, it is recommended that additional research be initiated to determine the frequency and prevalence of crossover in multifamily buildings. A random

sampling of multi-unit buildings should be selected as field sites, tested by the detection methods, and if crossover is found to be present, these buildings should be monitored for energy consumption by the hot water distribution system. This data will be analyzed against monitoring the same buildings after the crossover has been eliminated to determine an approximate percentage of energy savings. Further discussion of this analysis will be covered in the next phase of this study.

It should be stated that this report was focused on the methods of detecting crossover, once crossover has occurred. It was established that the root cause of crossover comes from a faulty mixing valve that allows water to leak into another subsystem. While this is critical information to better understanding crossover, the research team strongly suggests that more should be done to explore why mixing valves are made in a way that allows for crossover and further research on the cause of the valves allowing crossover. As a measure of innovation, the research and development of a cost-effective mixing valve that prevents crossover under any condition should be encouraged.

4.3.1 Recommendations for Applying Different Detection Methods Depending on the Situation

The Pressure Gauge method appeared to be the quickest, most efficient way to detect crossover at a building-wide level. It would be recommended to use this as an initial screening test on a building to then determine whether further testing needs to be done.

If the Pressure Gauge method shows crossover, then one of the other methods (Eatherton or Water Flow) could be used to pinpoint the crossover. If any of the methods did not detect crossover, it can be accurately assumed that the building does not have crossover.

In situations where there is not a good location to attach the pressure gauge, then the Water Flow method could be used as a substitute. This situation is unlikely as the pressure gauge can be installed anywhere on the hot water subsystem. If there are no available hose bibs, then the user of the method could attach it to an angle stop under a sink.

Both of these methods require a valve to be working on the cold water feed to the water heater, which shuts off water/pressure to the hot water subsystem. A trained plumber is the best person to conduct this test because that type of professional may be more competent in assessing whether the valve is sealing properly. If the valve is not sealing properly, the plumbing contractor has the ability to install a new valve.

Once a building is shown to have crossover at the building level, the next step to solving the problem is to pinpoint the faulty valve or valves that are allowing crossover. The Pressure Gauge method cannot do this, so the recommended methods for pinpointing would be either the Water Flow method or the Eatherton method.

The Water Flow method is slightly more invasive, as the draining of a building's hot water pipes can cause problems, including potentially crossover itself, but if the crossover is to be fixed, the building may need to be drained anyway. In the discussion of the Eatherton method, there were some hypothetical problems pointed out by the research team, which the Water Flow method does encounter or create.

The Eatherton method is the other option for pinpointing crossover in the building. It is much less invasive than the Water Flow method, as it does not require any interruptions to the

building's hot water service. The research team will investigate in the field, whether the hypothetical problems with the Eatherton method are actually problems, and if those hypotheses are rejected, then the research team recommends using the Eatherton method for pinpointing crossover in almost all situations.

Also, as mentioned above, the Pressure Gauge and Water Flow methods require a working shut-off valve on the cold water feed to the water heater, but the Eatherton method does not. So for a small building, it may be efficient and accurate to use the Eatherton method, unit by unit.

In summary, the general recommendation is to use the Pressure Gauge method to screen a building, and then use the Eatherton method to pinpoint the crossover.

4.4 Technology Transfer

The findings of this report can be utilized to expand the knowledge in the plumbing, energy efficiency, and water conservation industries and establish a foundation of scientific data for further research of crossover. Based on the conclusions of this particular phase of the study, the research team will be developing an instruction manual or best practice guide for those working in water or energy industries related to detecting crossover.

The instruction manual will contain descriptions of verified procedures and established protocols for detecting crossover that will help plumbing contractors to resolve issues related to hot water distribution. It will also provide guidance to energy efficiency and water conservation professionals such as HERS raters to develop education programs, seminars, and industry conferences focused on reducing energy waste related to hot water distribution. Lastly, it will be disseminated to water utility directors and water district managers who rely on such guidelines to implement enhanced water conservation efforts.

The research team is scheduled to rollout a more in depth technology transfer plan in the future that will include the entire scope of testing and results of every phase. From this interim report, the research team will begin the technology transfer process through a series of actions such as publishing the information on the research team's website (www.enovativegroup.com), promoting the report through press releases and article submissions to be covered in industry papers and magazines, and finally, disseminating the report's findings to the above mentioned stakeholders via tradeshows, association meetings, conferences, guest lectures, and local chapter industry mixers by offering interactive presentations, project demonstrations and detailed discussions. There will be a special coordination with the SoCal Gas Emerging Technology Team to conduct direct training and educational sessions at various resource centers located across California.

4.5 Next Steps

Now that the most effective methods for detecting crossover have been verified in a lab environment, the next step is rollout of a large-scale survey of actual buildings. The next phase will sample 100 multifamily buildings with normal occupancy rates, to determine, by use of the proven methods, the frequency of crossover. The research will include cataloging the building profiles, the types and designs of hot water distribution systems, types of fixtures and other characteristics potentially associated with the occurrence of crossover. The research will also highlight the profiles of buildings where crossover is not present.

Compiling this information will help the Energy Commission, Manufacturers, Contractors, Legislators, Policy Makers, Building owners, System Engineers, Energy Professionals, and Maintenance Technicians plan, prepare and organize the efforts around eliminating crossover and saving the energy it wastes.

At that point, the research team will be ready to move into the final technical phase. The final technical phase will be tasked with the challenge of calculating the average amount of energy wasted by crossover in a typical multifamily building. The sample set will consist of 10 buildings that are known to have crossover and monitor the energy consumption over a set amount of time. Then using the same 10 buildings, crossover will be corrected and eliminated. An equal amount of monitoring will be applied to the buildings without crossover in order to compare the energy usage. The difference in the findings should give the research team a rough estimate to the effects of crossover in terms of the energy saved by detecting and correcting it.

GLOSSARY

Term	Definition
Cartridge	A component to a shower mixing valve or other fixtures that mix hot and cold water that refers to the part of the valve that controls the flow of hot and cold water in order to provide the user with the desired temperature.
CEC	California Energy Commission
Cold Water Subsystem	The section of piping, valves, fixtures associated with the distribution of cold water that begins at the city supply line and includes the branching of pipes to end fixture delivering cold water
Crossover	The occurrence of a hot water supply incorrectly mixing with a cold water supply due to faulty valve in fixture or faucet
Data Acquisition Center	A computerized device that captures all the information logged by the temperature and pressure sensors into a centralized hub
DHW	An abbreviation for Domestic Hot Water (system)
Eatherton Method	A method for detecting crossover that is best used for pinpointing the location of crossover
Flow Meter	Gauge that digitally tracks direction of water flow through a water pipe
Hot Water Distribution System	The system of heating and piping that supplies hot water to a multifamily building
Hot Water Subsystem	The section of piping that begins at the water heater and includes the branching of pipes to end fixture delivering hot water
HWR	An abbreviation for Hot Water Return (line or pipe)
HWS	An abbreviation for Hot Water Supply (pipe)
Mixing Valve	A valve found in a shower fixture that is responsible for the blending of hot and cold water released to the end user
Pressure Gauge Method	A detection method for crossover that uses a pressure gauge on the hot water subsystem to indicate the presence of crossover or not

Pressure Gauge	Gauge that tracks water pressure in a water pipe
PRV	An abbreviation for pressure reducing valve. A Pressure Reducing Valve will reduce pressure to all the pipes downstream of the PRV.
Pump Control Method	
Recirculation Loop	The section of piping in the hot water subsystem that returns unused hot water back into the water heater
Recirculation Pump	The device responsible for creating a pull on the hot water subsystem that draws hot water back to the water heater
Shut-off Valve	A valve that allows plumbers and service technicians to isolate and segment sections of a pipe from the rest of the subsystem
Temperature Differential Method	
Temperature Sensor	A device that digitally monitors temperature
Test Platform	The laboratory created for this study designed to model a typical hot water system
TPR Valve	
Water Flow Method	A method for detecting crossover that monitors water flow in a hot water subsystem as an indication of crossover or not

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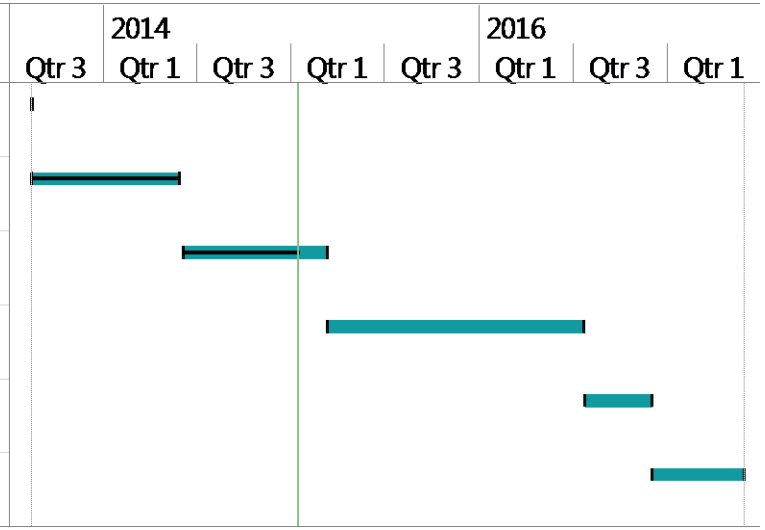
APPENDIX A:
Overall Study Timeline

ID	Task Mode	Task Name	Dura	Start	Finish
1		Kickoff	2 days	Wed 8/14/13	Thu 8/15/13
2		Task 2 - Determine How to Identify Crossover	205 days	Thu 8/15/13	Wed 5/28/14
3		Task 3 - Survey 100 Buildings	200 days	Thu 6/5/14	Wed 3/11/15
4		Task 4 - Monitor 10 Buildings	357 days	Thu 3/12/15	Fri 7/22/16
5		Task 6 - Create Codes and Standards	94 days	Mon 7/25/16	Thu 12/1/16
6		Task 7 - Technology Transfer	128 days	Fri 12/2/16	Tue 5/30/17



GANTT chart of major project milestones. Black lines indicates the current status .

APPENDIX B:
References to Detection Methods

The following section contains three separate documents that were used for research and reference for detecting crossovers and establishing the method.

Document 1 -

R.H.E.E.M. Manufacturing Company. (n.d.). Plumbing Crossover / Cross Connection. *R.U.U.D Heating*. Santa Monica, California, USA: Technical Service Department

Document 2 -

Rikos. (2013). Rikos Tipsheet. *Rikos Obline Bog*. Toronto, Ontario, Canada: Rikos . Retrieved from http://blog.rikos.com/Portals/175140/docs/Rikos_TipSheet_Crossovers.pdf

Document 3 -

Robinson, Mark, P.E.; (2008); Troubleshooting Hotel Hot Water Recirculation System.; www.markrobinsonpe.com

APPENDIX C:
Data from Testing Methods

The following section contains data accumulated from the lab experiments. It is organized in this section according to the order of its usage and appearance in the report.

The most pertinent and relevant data corresponding to the charts in the report are as follows:

- Pressure Gauge Method:
  - Scenario 2 – Test 3
  - Scenario 1 – Test 3
- Waterflow Method:
  - Scenario 2 – Test 3
  - Scenario 1 – Test 3
- Eatherton Method:
  - Scenario 2 – Test 4
  - Scenario 1 – Test 7
- Circ Through Cold
  - Discussed in Chapter 4 of the report

The following information is also a legend for all of the charts and tables displayed in the report as well as the appendices section.

Abbreviation	**Meaning**	**Legend**	**Color**
P	Pressure Data	P_WS_H	
T	Temperature Data	P_WS_C	
WS	Readings from the water Supply Line	T_WS_H	
SV3	Readings from the 3rd shower valve in the Lab setup	T_WS_C	
H	Hot Line	P_SV3_H	
C	Cold Line	P_SV3_C	
For example, 'P_WS_H" would represent the Pressure data obtained at the Hot section of the Water Supply Line.		T_SV3_H	
		T_SV3_C	

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Data from Pressure Gauge Method: Scenario 2, Test 3

	Date	P_SV3_C	P_SV3_H	T_WS_H	T_WS_C	T_SV3_H	P_WS_C	T_SV3_C	P_WS_H	Interval
PGaugeS2T3	02/05/2014	61.13	58.5	118.09	69.7	77.17	57.61	68.41	57.28	1
PGaugeS2T3	02/05/2014	61.11	58.5	118.09	69.18	77.17	57.61	68.41	57.28	2
PGaugeS2T3	02/05/2014	61.21	58.52	118.18	69.82	76.69	57.67	68.36	57.3	3
PGaugeS2T3	02/05/2014	61.11	58.5	118.14	69.78	76.59	57.57	68.38	57.28	4
PGaugeS2T3	02/05/2014	61.09	58.52	118.11	69.22	76.66	57.55	68.43	57.3	5
PGaugeS2T3	02/05/2014	61.19	58.52	118.04	69.82	76.59	57.47	68.41	57.22	6
PGaugeS2T3	02/05/2014	61.11	58.56	118.09	69.7	76.62	57.57	68.36	57.24	7
PGaugeS2T3	02/05/2014	60.22	53.94	118.06	69.15	76.59	57.55	68.34	57.22	8
PGaugeS2T3	02/05/2014	60.12	27.04	117.15	69.46	76.57	57.03	68.31	31.12	9
PGaugeS2T3	02/05/2014	59.23	23.46	117.7	69.42	78.13	56.31	68.05	27.89	10
PGaugeS2T3	02/05/2014	58.67	23.15	117.85	69.51	82.35	55.64	68.1	27.96	11
PGaugeS2T3	02/05/2014	57.82	23.15	117.9	69.51	85.71	54.5	68.17	28	12
PGaugeS2T3	02/05/2014	57.01	23.19	117.82	69.46	89.94	53.88	68.36	28	13
PGaugeS2T3	02/05/2014	56.35	22.95	117.82	69.75	93.68	53.2	68.41	27.79	14
PGaugeS2T3	02/05/2014	55.89	22.99	117.94	69.2	96.13	53.03	68.36	27.79	15
PGaugeS2T3	02/05/2014	55.83	22.92	117.82	69.18	99.34	52.74	68.31	27.77	16
PGaugeS2T3	02/05/2014	55.81	22.92	117.87	69.13	101.72	52.74	68.31	27.75	17
PGaugeS2T3	02/05/2014	56.29	22.92	117.85	69.82	104.38	52.95	68.31	27.94	18
PGaugeS2T3	02/05/2014	57.76	36.45	118.66	69.42	106.14	54.13	68.94	34.65	19
PGaugeS2T3	02/05/2014	58.5	40.71	118.42	69.44	105.92	55.15	68.67	39.28	20
PGaugeS2T3	02/05/2014	58.46	44.13	118.38	70.02	105.85	55.06	69.2	42.82	21
PGaugeS2T3	02/05/2014	58.94	55.42	118.69	70.04	105.56	55.33	68.94	45.93	22
PGaugeS2T3	02/05/2014	45.27	46.03	118.74	69.44	103.47	55.31	68.36	45.97	23
PGaugeS2T3	02/05/2014	36.94	37.36	118.78	70.11	102.08	55.15	69.06	46.01	24
PGaugeS2T3	02/05/2014	30.81	29.45	118.66	70.04	100.52	55.42	68.62	45.91	25
PGaugeS2T3	02/05/2014	24.64	24.6	118.78	70.14	99.06	55.39	68.12	45.99	26
PGaugeS2T3	02/05/2014	20.6	19.57	118.83	70.14	97.88	55.41	68.46	46.01	27
PGaugeS2T3	02/05/2014	15.76	15.95	118.71	70.09	96.94	55.12	68.36	45.99	28
PGaugeS2T3	02/05/2014	12.94	12.3	118.78	70.11	95.77	55.35	68.12	46.01	29
PGaugeS2T3	02/05/2014	10.46	9.96	118.78	69.51	94.88	55.42	68.38	45.99	30
PGaugeS2T3	02/05/2014	8.33	8.24	118.74	69.44	94.52	55.41	68.7	45.99	31
PGaugeS2T3	02/05/2014	6.79	6.42	118.71	70.02	93.94	55.39	68.94	46.01	32
PGaugeS2T3	02/05/2014	5.65	5.63	118.78	70.14	93.75	55.41	68.72	46.05	33
PGaugeS2T3	02/05/2014	4.66	4.41	118.71	69.46	93.32	55.41	68.67	46.03	34
PGaugeS2T3	02/05/2014	3.98	3.96	118.74	70.09	92.79	55.42	68.67	46.03	35
PGaugeS2T3	02/05/2014	3.48	3.23	118.76	70.16	93.06	55.42	69.01	46.03	36
PGaugeS2T3	02/05/2014	2.96	2.8	118.71	69.42	93.03	55.35	68.34	45.91	37
PGaugeS2T3	02/05/2014	2.51	2.57	118.71	69.46	93.03	55.41	68.96	45.95	38
PGaugeS2T3	02/05/2014	2.48	2.28	118.74	70.02	92.36	55.37	68.31	45.97	39

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	Date	P_SV3_C	P_SV3_H	T_WS_H	T_WS_C	T_SV3_H	P_WS_C	T_SV3_C	P_WS_H	Interval
PGaugeS2T3	02/05/2014	2.32	2.09	118.69	69.39	92.43	55.39	69.01	45.99	40
PGaugeS2T3	02/05/2014	2.03	1.84	118.71	69.49	92.43	55.37	68.96	45.99	41
PGaugeS2T3	02/05/2014	1.8	1.55	118.66	69.8	92.46	55.33	68.29	45.93	42
PGaugeS2T3	02/05/2014	1.82	1.37	118.64	70.09	92.72	55.42	68.96	45.97	43
PGaugeS2T3	02/05/2014	1.62	1.33	118.74	70.02	92.12	55.37	68.65	45.95	44
PGaugeS2T3	02/05/2014	1.26	1.35	118.74	69.44	92.17	55.33	68.6	45.76	45
PGaugeS2T3	02/05/2014	1.35	1.1	118.09	69.39	92.14	55.35	68.62	18.33	46
PGaugeS2T3	02/05/2014	1.3	1.02	118.76	70.04	92.17	55.39	68.7	6.21	47
PGaugeS2T3	02/05/2014	1.12	1.02	119.19	69.54	92.22	55.41	68.72	1.8	48
PGaugeS2T3	02/05/2014	1.18	1.1	119.05	69.42	91.57	55.41	68.65	0.08	49
PGaugeS2T3	02/05/2014	1.1	1.04	119.05	69.92	91.64	55.46	68.96	-0.37	50
PGaugeS2T3	02/05/2014	1.1	0.81	119.02	69.39	91.52	55.41	68.6	-0.68	51
PGaugeS2T3	02/05/2014	1.06	0.93	119.05	69.44	91.52	55.37	68.62	-0.66	52
PGaugeS2T3	02/05/2014	1.14	0.91	119.02	69.44	91.62	55.37	68.62	-0.89	53
PGaugeS2T3	02/05/2014	1.08	0.83	119	69.39	90.9	55.37	68.62	-0.91	54
PGaugeS2T3	02/05/2014	1.08	0.91	119	69.42	90.92	55.39	68.6	-0.91	55
PGaugeS2T3	02/05/2014	0.85	0.87	119.05	69.44	90.94	55.42	68.72	-0.87	56
PGaugeS2T3	02/05/2014	0.93	0.85	119.1	69.54	91.06	55.46	68.72	-1.08	57
PGaugeS2T3	02/05/2014	0.91	0.83	119.05	69.92	90.63	55.41	68.67	-1.1	58
PGaugeS2T3	02/05/2014	0.93	0.81	119	69.44	90.61	55.35	68.7	-1.08	59
PGaugeS2T3	02/05/2014	0.79	0.85	118.95	69.42	90.61	55.42	68.65	-1.14	60
PGaugeS2T3	02/05/2014	0.91	0.85	119	70.04	90.75	55.39	68.05	-1.04	61
PGaugeS2T3	02/05/2014	0.85	0.83	119.05	69.44	90.66	55.39	68.7	-1.12	62
PGaugeS2T3	02/05/2014	0.89	0.83	119.14	69.49	90.18	55.42	68.74	-1.06	63
PGaugeS2T3	02/05/2014	0.79	0.89	118.95	69.42	90.06	55.41	68.6	-1.14	64
PGaugeS2T3	02/05/2014	0.95	0.85	119.14	69.44	90.13	55.42	68.67	-1.12	65
PGaugeS2T3	02/05/2014	0.83	0.89	119.02	69.39	90.06	55.35	68.62	-1.1	66
PGaugeS2T3	02/05/2014	0.85	0.91	118.93	69.42	90.08	55.31	68.62	-1.12	67
PGaugeS2T3	02/05/2014	0.83	0.93	119.05	69.42	89.5	55.46	68.67	-1.12	68
PGaugeS2T3	02/05/2014	0.91	0.81	118.5	69.49	89.53	55.39	68.19	-1.08	69
PGaugeS2T3	02/05/2014	0.87	0.89	119	69.39	89.46	55.31	68.1	-1.16	70
PGaugeS2T3	02/05/2014	0.87	0.64	118.45	69.44	89.05	55.33	68.6	-1.08	71
PGaugeS2T3	02/05/2014	0.91	0.85	118.52	69.54	89.48	55.42	68.12	-1.08	72
PGaugeS2T3	02/05/2014	0.85	0.6	118.38	69.46	88.93	55.39	68.67	-1.04	73
PGaugeS2T3	02/05/2014	0.87	0.56	118.45	69.42	88.83	55.44	68.67	-1.08	74
PGaugeS2T3	02/05/2014	0.91	0.66	118.42	69.42	88.86	55.42	68.6	-1.14	75
PGaugeS2T3	02/05/2014	0.89	0.54	118.42	69.44	88.26	55.41	68.05	-1.06	76
PGaugeS2T3	02/05/2014	0.85	0.56	118.42	69.44	88.83	55.35	68.72	-1.08	77
PGaugeS2T3	02/05/2014	0.97	0.6	118.52	69.49	88.26	55.37	68.1	-1.04	78
PGaugeS2T3	02/05/2014	0.83	0.64	118.42	69.46	88.26	55.39	68.07	-1.12	79

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	Date	P_SV3_C	P_SV3_H	T_WS_H	T_WS_C	T_SV3_H	P_WS_C	T_SV3_C	P_WS_H	Interval
PGaugeS2T3	02/05/2014	0.89	0.58	118.42	69.44	88.3	55.44	68.07	-1.06	80
PGaugeS2T3	02/05/2014	0.87	0.58	118.47	69.54	88.33	55.42	68.26	-1.02	81
PGaugeS2T3	02/05/2014	0.85	0.6	118.42	68.86	88.23	55.44	68.65	-1.08	82
PGaugeS2T3	02/05/2014	0.93	0.58	118.42	69.18	87.94	52.27	68.72	-1.08	83
PGaugeS2T3	02/05/2014	0.97	0.6	118.5	69.51	88.04	50.15	68.7	-1.02	84
PGaugeS2T3	02/05/2014	0.87	0.64	118.35	69.44	87.97	50.51	68.6	-1.14	85
PGaugeS2T3	02/05/2014	0.85	0.6	118.4	69.08	87.99	52.72	68.6	-1.08	86
PGaugeS2T3	02/05/2014	0.89	0.6	118.33	69.1	87.97	53.14	68.02	-1.1	87
PGaugeS2T3	02/05/2014	0.81	0.64	118.38	69.7	87.39	53.43	68.05	-1.16	88
PGaugeS2T3	02/05/2014	0.87	0.6	118.45	69.1	87.44	53.7	68.05	-1.08	89
PGaugeS2T3	02/05/2014	0.75	0.6	118.38	69.42	87.32	54.71	68.65	-1.12	90
PGaugeS2T3	02/05/2014	0.85	0.56	118.45	69.46	87.42	55.56	68.07	-1.06	91
PGaugeS2T3	02/05/2014	0.89	0.6	118.38	69.42	87.32	55.37	68.62	-1.08	92
PGaugeS2T3	02/05/2014	0.89	0.6	118.4	69.44	87.34	55.41	68.65	-1.1	93
PGaugeS2T3	02/05/2014	0.81	0.64	118.38	69.42	86.77	55.41	68.67	-1.16	94
PGaugeS2T3	02/05/2014	0.89	0.85	118.42	69.46	87.39	55.62	68.05	-1.06	95
PGaugeS2T3	02/05/2014	0.81	0.87	118.35	69.42	87.34	55.37	68.62	-1.1	96
PGaugeS2T3	02/05/2014	0.89	0.85	118.95	69.46	86.82	55.33	68.02	-1.14	97
PGaugeS2T3	02/05/2014	0.85	0.81	117.82	69.49	86.79	55.41	68.05	-1.08	98
PGaugeS2T3	02/05/2014	0.93	0.62	118.5	69.49	86.96	55.35	68.7	-1.06	99
PGaugeS2T3	02/05/2014	0.85	0.56	118.45	69.39	86.77	55.33	68.38	-1.06	100
PGaugeS2T3	02/05/2014	0.87	0.6	118.38	69.44	86.77	55.41	68.65	-1.12	101

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Data from Pressure Gauge Method Scenario 1, Test 3

	Date	Interval	P_SV3_C	P_SV3_H	T_HWS	T_CWS	T_SV3_H	P_CWS	T_SV3_C	P_HWS
PGaugeS1T3	02/05/2014	1	59.97	57.26	121.98	68.89	68.07	56.33	66.82	56.02
PGaugeS1T3	02/05/2014	2	60.2	57.3	121.98	68.84	68.62	56.6	66.85	56.31
PGaugeS1T3	02/05/2014	3	60.2	57.32	121.93	68.84	68.58	56.6	66.8	56.29
PGaugeS1T3	02/05/2014	4	60.22	57.36	121.98	68.86	68.02	56.6	66.85	56.28
PGaugeS1T3	02/05/2014	5	60.26	57.28	121.95	68.94	68.5	56.62	66.87	56.33
PGaugeS1T3	02/05/2014	6	59.99	57.26	122.1	68.86	68.02	56.39	66.66	56.35
PGaugeS1T3	02/05/2014	7	59.95	57.26	121.35	68.91	68.6	56.41	66.54	56.1
PGaugeS1T3	02/05/2014	8	59.93	57.26	121.4	68.31	68.62	56.41	66.61	56.06
PGaugeS1T3	02/05/2014	9	59.99	57.34	121.47	68.89	68.02	56.45	66.58	56.02
PGaugeS1T3	02/05/2014	10	59.95	57.28	122.02	68.89	67.95	56.39	66.82	56.06
PGaugeS1T3	02/05/2014	11	60.01	57.24	122.02	68.91	68	56.35	66.82	56.06
PGaugeS1T3	02/05/2014	12	59.97	57.32	121.5	68.94	68.67	56.43	66.85	56.08
PGaugeS1T3	02/05/2014	13	59.51	27.91	121.35	68.89	67.71	56.06	66.56	36.38
PGaugeS1T3	02/05/2014	14	58.58	23.09	121.71	68.94	68.31	55.41	67.21	28.16
PGaugeS1T3	02/05/2014	15	58.07	23.42	121.16	68.6	68.14	54.67	66.58	28.52
PGaugeS1T3	02/05/2014	16	57.59	23.11	121.42	69.15	68.65	54.46	66.58	28.25
PGaugeS1T3	02/05/2014	17	57.01	22.97	121.11	69.1	73.09	53.9	66.25	28.2
PGaugeS1T3	02/05/2014	18	57.03	22.94	121.35	69.22	78.68	53.9	66.9	28.22
PGaugeS1T3	02/05/2014	19	57.24	23.17	121.38	68.6	81.39	54.15	66.56	28.47
PGaugeS1T3	02/05/2014	20	57.78	23.36	121.45	69.2	86.19	54.69	67.16	28.76
PGaugeS1T3	02/05/2014	21	58.07	23.67	121.45	68.94	90.42	54.88	67.18	28.93
PGaugeS1T3	02/05/2014	22	58.31	23.61	120.82	68.82	95.19	55.17	67.18	28.97
PGaugeS1T3	02/05/2014	23	58.29	23.63	121.42	69.42	97.52	55.15	66.58	28.95
PGaugeS1T3	02/05/2014	24	58.34	23.67	120.8	69.46	100.23	54.92	67.21	28.97
PGaugeS1T3	02/05/2014	25	57.76	23.65	121.42	69.44	102.63	54.67	67.16	29.01
PGaugeS1T3	02/05/2014	26	57.28	23.65	120.82	70.06	104.1	54.42	67.83	29.01
PGaugeS1T3	02/05/2014	27	57.34	23.4	121.5	70.71	108.06	54.23	68.07	28.97
PGaugeS1T3	02/05/2014	28	57.3	23.65	120.8	71.22	109.74	54.15	68.65	28.95
PGaugeS1T3	02/05/2014	29	57.55	23.86	120.8	71.53	111.27	54.42	69.82	28.85
PGaugeS1T3	02/05/2014	30	57.8	23.9	120.85	71.58	112.62	54.5	70.14	28.95
PGaugeS1T3	02/05/2014	31	58.52	36.05	121.35	72.15	112.76	55.13	70.66	32.31
PGaugeS1T3	02/05/2014	32	58.71	38.99	121.4	72.56	112.42	55.46	71.6	37.38
PGaugeS1T3	02/05/2014	33	58.98	43.11	121.45	73.06	109.83	55.73	72.49	41.87
PGaugeS1T3	02/05/2014	34	58.98	47.01	121.38	73.62	107.7	55.6	73.14	45.47
PGaugeS1T3	02/05/2014	35	59.29	49.84	121.09	73.66	105.94	55.85	73.74	48.15
PGaugeS1T3	02/05/2014	36	59	52.5	121.47	73.66	105.1	55.73	74.22	51.23
PGaugeS1T3	02/05/2014	37	58.71	54.21	121.06	74.22	103.18	55.33	74.82	52.87
PGaugeS1T3	02/05/2014	38	59.02	55.35	121.18	74.6	101.41	55.42	75.2	53.95
PGaugeS1T3	02/05/2014	39	59.25	56.08	121.16	74.58	100.26	55.85	75.25	54.86
PGaugeS1T3	02/05/2014	40	58.98	56.41	120.75	74.53	98.38	55.81	75.85	55.02
PGaugeS1T3	02/05/2014	41	59.23	56.57	120.8	75.25	98.14	55.93	75.2	55.37
PGaugeS1T3	02/05/2014	42	59.52	56.78	120.85	75.22	96.99	56.22	76.42	55.41
PGaugeS1T3	02/05/2014	43	59.72	57.09	120.82	75.13	95.77	56.16	76.11	55.58
PGaugeS1T3	02/05/2014	44	59.56	56.97	120.85	75.18	95.17	56.18	76.4	55.6
PGaugeS1T3	02/05/2014	45	59.78	57.07	120.85	75.2	94.3	56.41	76.18	55.6
PGaugeS1T3	02/05/2014	46	59.45	57.05	120.8	75.15	94.09	56.35	76.38	55.64
PGaugeS1T3	02/05/2014	47	59.49	57.07	120.85	75.1	93.06	56.39	76.74	55.54
PGaugeS1T3	02/05/2014	48	59.43	57.07	120.75	75.75	93.03	56.14	76.33	55.56
PGaugeS1T3	02/05/2014	49	59.47	57.13	120.78	75.75	92.41	56.08	76.95	55.64
PGaugeS1T3	02/05/2014	50	59.51	56.88	120.82	75.68	91.81	56.06	77.02	55.54
PGaugeS1T3	02/05/2014	51	59.2	56.86	120.75	75.7	91.52	56.14	77.02	55.33
PGaugeS1T3	02/05/2014	52	59.25	56.88	120.46	75.75	91.76	56.08	77.02	55.31

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	Date	Interval	P_SV3_C	P_SV3_H	T_HWS	T_CWS	T_SV3_H	P_CWS	T_SV3_C	P_HWS
PGaugeS1T3	02/05/2014	53	59.23	56.86	120.46	75.1	91.59	55.85	76.98	55.35
PGaugeS1T3	02/05/2014	54	59.2	56.82	120.44	75.82	91.54	55.79	77	55.39
PGaugeS1T3	02/05/2014	55	59.27	56.78	120.49	75.8	90.92	55.81	77.02	55.37
PGaugeS1T3	02/05/2014	56	59.25	56.55	120.44	75.15	90.99	55.89	77.02	55.35
PGaugeS1T3	02/05/2014	57	59.27	56.57	120.54	75.15	91.69	55.95	77.07	55.37
PGaugeS1T3	02/05/2014	58	59.23	56.57	120.54	75.13	90.97	55.93	77.05	55.41
PGaugeS1T3	02/05/2014	59	59.21	56.6	120.46	75.7	90.94	55.79	77.02	55.37
PGaugeS1T3	02/05/2014	60	59.2	56.58	120.44	75.08	90.87	55.83	77.19	55.37
PGaugeS1T3	02/05/2014	61	59	56.64	120.44	75.06	90.3	55.81	77.29	55.06
PGaugeS1T3	02/05/2014	62	58.98	56.62	119.94	75.15	90.94	55.89	77.26	55.37
PGaugeS1T3	02/05/2014	63	59.21	56.6	119.91	75.1	90.73	55.81	77.22	55.39
PGaugeS1T3	02/05/2014	64	58.96	56.6	119.86	75.18	90.34	55.87	77.29	55.29
PGaugeS1T3	02/05/2014	65	59.16	56.62	120.46	75.8	90.39	55.83	77.29	55.31
PGaugeS1T3	02/05/2014	66	59.2	56.62	120.03	75.22	90.46	55.93	77.36	55.37
PGaugeS1T3	02/05/2014	67	59.2	56.55	119.89	75.13	90.37	55.81	77	55.33
PGaugeS1T3	02/05/2014	68	59.29	56.62	119.91	75.1	90.46	55.83	77.26	55.33
PGaugeS1T3	02/05/2014	69	59.29	56.57	120.01	75.82	90.42	55.87	77.34	55.37
PGaugeS1T3	02/05/2014	70	59.23	56.6	119.96	75.15	90.37	55.87	77.26	55.37
PGaugeS1T3	02/05/2014	71	59.23	56.6	119.89	75.78	89.77	55.77	77.29	55.35
PGaugeS1T3	02/05/2014	72	59.21	56.58	119.89	75.7	90.3	55.79	77.34	55.41
PGaugeS1T3	02/05/2014	73	59.23	56.66	119.89	75.08	90.34	55.83	77.24	55.29
PGaugeS1T3	02/05/2014	74	59.21	56.62	119.86	75.37	89.74	55.81	77.34	55.35
PGaugeS1T3	02/05/2014	75	59.21	56.58	119.86	75.75	89.65	55.79	77.34	55.37
PGaugeS1T3	02/05/2014	76	59.21	56.55	119.94	75.06	89.79	55.81	77.26	55.35
PGaugeS1T3	02/05/2014	77	59.25	56.55	119.94	75.78	89.79	55.87	77.26	55.35
PGaugeS1T3	02/05/2014	78	59.2	56.62	119.24	75.01	89.7	55.81	77.26	55.35
PGaugeS1T3	02/05/2014	79	59.29	56.57	119.34	75.15	89.67	55.91	77.84	55.41
PGaugeS1T3	02/05/2014	80	59.25	56.57	119.29	75.06	89.5	55.81	77.34	55.41
PGaugeS1T3	02/05/2014	81	59.2	56.6	119.26	75.68	89.43	55.83	77.22	55.31
PGaugeS1T3	02/05/2014	82	59.18	56.62	119.22	75.73	90.06	55.87	77.29	55.33
PGaugeS1T3	02/05/2014	83	58.92	56.62	119.34	75.13	89.48	55.83	77.26	55.1
PGaugeS1T3	02/05/2014	84	59.06	56.57	119.34	75.78	89.5	55.66	77.31	55.39
PGaugeS1T3	02/05/2014	85	58.98	56.33	119.24	75.75	89.46	55.62	77.94	51.81
PGaugeS1T3	02/05/2014	86	58.73	24.1	118.76	75.8	88.5	55.44	77.62	19.82
PGaugeS1T3	02/05/2014	87	58.44	13.36	118.69	75.63	88.21	55.12	77.5	10.89
PGaugeS1T3	02/05/2014	88	58.29	8.53	119.34	75.78	87.97	55.15	77.82	4.47
PGaugeS1T3	02/05/2014	89	58.04	5.67	119.65	75.13	87.44	54.71	77.6	2.51
PGaugeS1T3	02/05/2014	90	57.73	4.47	119.26	75.39	87.1	54.4	77.53	1.04
PGaugeS1T3	02/05/2014	91	57.75	4.22	119.91	75.42	87.06	54.42	77.55	0.52
PGaugeS1T3	02/05/2014	92	57.51	4.02	119.31	76.06	86.31	54.34	78.1	0.33
PGaugeS1T3	02/05/2014	93	57.22	3.95	119.89	75.37	85.9	54.13	78.15	0.31
PGaugeS1T3	02/05/2014	94	57.22	3.77	119.89	75.39	85.57	53.9	78.44	0.33
PGaugeS1T3	02/05/2014	95	57.26	3.73	119.89	76.09	85.02	54.13	78.46	0.33
PGaugeS1T3	02/05/2014	96	57.53	3.77	119.86	76.06	84.42	54.15	78.51	0.35
PGaugeS1T3	02/05/2014	97	57.53	3.73	119.96	75.42	84.13	54.4	78.44	0.39
PGaugeS1T3	02/05/2014	98	57.53	3.71	119.94	76.04	84.1	54.42	78.49	0.29
PGaugeS1T3	02/05/2014	99	57.47	3.96	119.91	75.37	82.88	54.4	78.13	0.37
PGaugeS1T3	02/05/2014	100	57.55	3.77	119.29	76.02	82.26	54.15	78.18	0.27
PGaugeS1T3	02/05/2014	101	57.49	3.98	119.02	76.02	82.02	54.44	77.55	0.33
PGaugeS1T3	02/05/2014	102	57.84	3.93	119.12	76.06	81.46	54.48	77.62	0.41
PGaugeS1T3	02/05/2014	103	57.75	3.79	118.4	76.09	80.79	54.4	77.58	0.29
PGaugeS1T3	02/05/2014	104	57.57	3.73	117.85	75.39	80.24	54.42	77.6	0.39
PGaugeS1T3	02/05/2014	105	57.38	3.95	116.77	75.49	79.98	53.97	77.02	0.39
PGaugeS1T3	02/05/2014	106	57.05	4.02	116.43	75.46	79.38	53.95	76.9	0.27

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	Date	Interval	P_SV3_C	P_SV3_H	T_HWS	T_CWS	T_SV3_H	P_CWS	T_SV3_C	P_HWS
PGaugeS1T3	02/05/2014	107	57.03	3.93	115.21	75.49	78.73	53.66	76.64	0.35
PGaugeS1T3	02/05/2014	108	56.97	3.95	114.51	75.39	78.1	53.68	76.09	0.33
PGaugeS1T3	02/05/2014	109	56.97	3.98	113.29	75.39	77.86	53.66	75.63	0.29
PGaugeS1T3	02/05/2014	110	57.03	3.89	113.1	74.82	77.89	53.68	75.54	0.31
PGaugeS1T3	02/05/2014	111	57.36	3.95	111.97	75.39	76.66	53.99	75.25	0.39
PGaugeS1T3	02/05/2014	112	57.57	3.95	111.25	74.79	76.35	54.4	74.22	0.39
PGaugeS1T3	02/05/2014	113	57.76	3.91	110.07	74.89	76.38	54.44	74.24	0.37
PGaugeS1T3	02/05/2014	114	57.73	3.96	109.16	74.89	75.82	54.5	74	0.37
PGaugeS1T3	02/05/2014	115	57.57	3.93	108.54	74.82	75.75	54.38	73.98	0.91
PGaugeS1T3	02/05/2014	116	57.28	5.18	108.01	74.82	75.15	54.4	73.98	1.74
PGaugeS1T3	02/05/2014	117	57.76	6.15	107.36	74.74	74.91	54.34	73.35	2.78
PGaugeS1T3	02/05/2014	118	57.98	7.81	106.14	74.74	74.86	54.63	73.42	4.16
PGaugeS1T3	02/05/2014	119	58.27	9.07	105.22	74.77	74.58	55.13	72.75	5.82
PGaugeS1T3	02/05/2014	120	59.02	10.67	104.19	74.26	74.02	55.46	72.3	7.6
PGaugeS1T3	02/05/2014	121	59.25	12.9	103.5	74.5	73.69	56.12	72.27	9.65
PGaugeS1T3	02/05/2014	122	59.7	14.99	102.61	74.48	73.64	56.33	72.2	12.05
PGaugeS1T3	02/05/2014	123	59.78	18.14	102.1	73.95	73.76	56.14	72.32	15.41
PGaugeS1T3	02/05/2014	124	59.23	21.06	101.29	74.14	73.33	56	72.15	18.57
PGaugeS1T3	02/05/2014	125	59.25	24.44	99.9	74.22	73.14	55.81	72.18	21.7
PGaugeS1T3	02/05/2014	126	58.96	28.72	99.3	74.22	72.97	55.81	71.55	26.71
PGaugeS1T3	02/05/2014	127	59.21	32.57	98.67	73.69	72.13	55.79	71.65	30.59
PGaugeS1T3	02/05/2014	128	59.18	37.4	98.41	73.62	72.51	55.81	71.24	35.16
PGaugeS1T3	02/05/2014	129	59.27	41.37	97.9	74.26	72.56	55.85	71.34	40.44
PGaugeS1T3	02/05/2014	130	59.23	46.28	96.92	74.14	72.44	55.85	70.66	44.48
PGaugeS1T3	02/05/2014	131	59.25	49.62	96.34	74.17	71.84	55.87	70.76	48.19
PGaugeS1T3	02/05/2014	132	59.33	52.21	95.53	73.71	72.25	55.93	70.78	51.79
PGaugeS1T3	02/05/2014	133	59.2	54.67	95.22	73.62	71.62	55.93	70.66	53.47
PGaugeS1T3	02/05/2014	134	59.21	55.81	94.54	73.64	71.84	55.93	70.76	55.1
PGaugeS1T3	02/05/2014	135	59.29	56.33	94.5	73.59	71.89	55.79	70.74	55.6
PGaugeS1T3	02/05/2014	136	59.25	56.62	93.9	73.62	71.79	55.89	70.66	55.58
PGaugeS1T3	02/05/2014	137	59.2	56.6	93.99	73.66	71.89	55.93	70.11	55.77
PGaugeS1T3	02/05/2014	138	59.18	56.58	93.34	73.69	71.36	55.81	70.66	55.77
PGaugeS1T3	02/05/2014	139	59.21	56.62	93.01	73.04	71.31	55.89	70.14	55.54
PGaugeS1T3	02/05/2014	140	59.23	56.62	92.43	73.64	71.86	55.91	70.11	55.54
PGaugeS1T3	02/05/2014	141	59.18	56.6	92.41	72.97	71.79	55.85	70.06	55.56
PGaugeS1T3	02/05/2014	142	59.23	56.6	91.83	72.99	71.53	55.87	70.16	55.56
PGaugeS1T3	02/05/2014	143	59.29	56.53	91.88	73.64	71.53	55.87	70.14	55.87
PGaugeS1T3	02/05/2014	144	59.29	56.57	91.88	73.09	71.38	55.91	70.18	55.75
PGaugeS1T3	02/05/2014	145	59.29	56.57	91.3	73.02	71.55	55.89	70.11	55.79

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Data from Water Flow Method Scenario 2, Test 3

		Interval	T_WS_H	T_WS_C	P_WS_H	P_WS_C	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS2T3	02/20/2014	1	121.16	70.57	32.6	54.61	69.18	70.64	3.21	3
WFS2T3	02/20/2014	2	121.11	71	32.49	54.73	69.27	70.74	3.27	3
WFS2T3	02/20/2014	3	121.16	70.98	32.53	54.69	68.96	70.71	3.21	3.02
WFS2T3	02/20/2014	4	121.11	71	32.57	54.69	69.22	70.09	3.23	2.98
WFS2T3	02/20/2014	5	121.06	70.93	32.53	54.65	68.98	70.64	3.19	2.96
WFS2T3	02/20/2014	6	121.06	70.93	32.59	54.59	69.15	70.64	3.21	2.9
WFS2T3	02/20/2014	7	121.11	70.95	32.59	54.63	68.96	70.66	3.25	2.88
WFS2T3	02/20/2014	8	121.16	70.93	32.62	54.59	69.13	70.66	3.17	3.02
WFS2T3	02/20/2014	9	121.06	70.62	32.55	54.65	69.2	70.64	3.27	2.9
WFS2T3	02/20/2014	10	121.11	71	32.57	54.69	69.22	70.14	3.27	3.07
WFS2T3	02/20/2014	11	121.09	70.98	32.53	54.65	69.01	70.74	3.27	2.94
WFS2T3	02/20/2014	12	121.16	70.95	32.53	54.71	69.2	70.66	3.23	3.02
WFS2T3	02/20/2014	13	121.11	70.98	32.53	54.73	68.98	70.69	3.23	3
WFS2T3	02/20/2014	14	121.18	71	32.51	54.71	68.98	70.71	3.27	3.06
WFS2T3	02/20/2014	15	121.02	70.9	32.51	54.61	68.96	70.62	3.25	2.92
WFS2T3	02/20/2014	16	121.11	71.02	32.55	54.71	69.25	70.66	3.27	3.04
WFS2T3	02/20/2014	17	121.14	71.02	32.49	54.73	69.01	70.5	3.02	3.04
WFS2T3	02/20/2014	18	120.39	70.9	32.55	54.63	69.44	70.59	2.98	2.98
WFS2T3	02/20/2014	19	121.06	70.57	32.57	54.65	69.54	70.62	3.23	2.96
WFS2T3	02/20/2014	20	121.11	71	32.74	54.65	69.49	70.74	3.23	3.04
WFS2T3	02/20/2014	21	121.16	70.95	32.78	54.67	69.51	70.18	3.23	2.96
WFS2T3	02/20/2014	22	121.06	70.98	32.84	54.67	68.94	70.09	2.96	3.02
WFS2T3	02/20/2014	23	121.09	70.93	32.74	54.59	69.03	70.69	3.21	2.94
WFS2T3	02/20/2014	24	121.11	70.98	32.99	54.65	68.91	70.76	3.23	3.04
WFS2T3	02/20/2014	25	121.11	70.98	32.97	54.67	69.01	70.71	3.25	3.02
WFS2T3	02/20/2014	26	121.14	70.98	32.99	54.67	68.96	70.14	3.27	2.98
WFS2T3	02/20/2014	27	121.04	70.86	33.01	54.59	69.18	70.04	3.19	2.96
WFS2T3	02/20/2014	28	121.16	70.98	33.22	54.73	69.18	70.74	3.29	3
WFS2T3	02/20/2014	29	121.14	71.02	33.28	54.65	69.2	70.81	3.25	55.37
WFS2T3	02/20/2014	30	121.14	70.98	33.22	54.69	69.2	70.4	57.78	55.37

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		Interval	T_WS_H	T_WS_C	P_WS_H	P_WS_C	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS2T3	02/20/2014	31	121.11	70.95	33.32	54.73	69.2	70.42	57.75	55.15
WFS2T3	02/20/2014	32	121.14	71.05	33.24	54.69	68.72	70.42	57.82	55.39
WFS2T3	02/20/2014	33	121.16	70.98	33.28	54.67	69.22	70.4	57.76	55.46
WFS2T3	02/20/2014	34	121.71	70.98	33.26	53.49	68.67	67.86	57.78	20.85
WFS2T3	02/20/2014	35	121.11	71.29	33.22	52.7	68.98	70.42	54.71	46.05
WFS2T3	02/20/2014	36	121.11	70.98	33.2	51.98	68.67	70.4	53.92	45.06
WFS2T3	02/20/2014	37	121.09	70.95	33.26	50.84	69.27	69.82	52.78	44.32
WFS2T3	02/20/2014	38	121.02	71.29	33.26	49.8	68.91	70.66	51.46	42.85
WFS2T3	02/20/2014	39	121.02	71.22	33.28	48.89	68.96	70.66	50.76	42.37
WFS2T3	02/20/2014	40	121.09	70.66	33.36	48.64	68.98	70.66	50.3	42.35
WFS2T3	02/20/2014	41	121.09	71.17	33.3	48.37	68.94	70.06	50.26	41.93
WFS2T3	02/20/2014	42	121.04	71.19	33.26	48.13	68.96	70.09	50.05	41.62
WFS2T3	02/20/2014	43	121.09	70.93	33.3	48.15	68.94	70.14	50.03	41.64
WFS2T3	02/20/2014	44	121.11	71	33.28	48.68	69.06	70.14	50.36	41.96
WFS2T3	02/20/2014	45	121.11	70.98	33.28	48.46	68.96	70.66	50.07	42.18
WFS2T3	02/20/2014	46	121.04	70.9	33.3	48.44	68.94	70.18	50.09	41.89
WFS2T3	02/20/2014	47	121.09	70.9	33.36	48.64	68.94	70.09	50.03	42.16
WFS2T3	02/20/2014	48	121.02	70.86	33.3	48.56	68.94	70.06	50.24	42.12
WFS2T3	02/20/2014	49	121.11	70.64	33.3	48.93	68.98	70.09	50.78	42.35
WFS2T3	02/20/2014	50	121.09	70.62	33.3	49.82	68.89	70.64	51.5	43.26
WFS2T3	02/20/2014	51	121.06	70.59	33.26	50.53	68.6	70.33	52.2	42.12
WFS2T3	02/20/2014	52	121.09	70.28	33.3	52.49	68.96	70.62	55.81	53.18
WFS2T3	02/20/2014	53	121.09	70.4	33.22	53.2	68.41	70.38	56.33	53.94
WFS2T3	02/20/2014	54	121.06	70.3	33.26	52.89	68.31	70.3	56.28	53.86
WFS2T3	02/20/2014	55	121.11	70.4	33.26	53.22	68.43	70.42	56.58	53.94
WFS2T3	02/20/2014	56	120.8	69.73	34.02	53.14	68.29	70.66	56.31	36.84
WFS2T3	02/20/2014	57	121.14	69.78	37.09	52.72	68.34	70.4	56.12	39.51
WFS2T3	02/20/2014	58	121.42	69.82	40.13	52.74	68.34	70.11	56.12	42.41
WFS2T3	02/20/2014	59	121.14	69.8	38.31	52.54	68.89	70.18	55.87	27.02
WFS2T3	02/20/2014	60	121.14	69.75	28.18	51.77	68.36	70.16	55.12	22.47
WFS2T3	02/20/2014	61	121.11	69.75	27.54	51.31	68.67	70.11	54.4	22.49

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		Interval	T_WS_H	T_WS_C	P_WS_H	P_WS_C	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS2T3	02/20/2014	62	121.16	70.11	27.5	50.84	68.67	70.14	54.17	22.51
WFS2T3	02/20/2014	63	121.06	69.37	27.48	50.07	68.6	71.1	53.12	22.22
WFS2T3	02/20/2014	64	121.06	69.46	27.48	49.6	68.7	76.35	52.93	21.93
WFS2T3	02/20/2014	65	121.16	69.75	27.21	49.37	68.38	81.44	52.76	22.26
WFS2T3	02/20/2014	66	121.11	69.78	27.23	49.16	68.34	85.02	52.45	22.03
WFS2T3	02/20/2014	67	121.06	69.8	27.27	48.95	68.36	88.86	52	21.97
WFS2T3	02/20/2014	68	121.11	69.8	27.17	49.12	68.38	93.06	52.23	22.26
WFS2T3	02/20/2014	69	121.16	69.78	27.52	49.66	68.34	96.97	52.74	22.22
WFS2T3	02/20/2014	70	121.09	69.44	27.5	50.32	68.38	99.94	53.51	22.39
WFS2T3	02/20/2014	71	121.06	69.42	27.89	51.27	67.95	101.7	54.38	22.9
WFS2T3	02/20/2014	72	121.06	69.7	28.25	51.48	68.6	104.62	54.84	22.88
WFS2T3	02/20/2014	73	121.11	69.73	28.2	51.54	68	107.36	55.08	23.13
WFS2T3	02/20/2014	74	121.5	69.8	30.61	52.02	68.36	108.06	55.39	34.69
WFS2T3	02/20/2014	75	120.82	69.8	35.64	52.29	68.07	107.7	55.64	38.35
WFS2T3	02/20/2014	76	121.09	69.78	38.37	52.2	68.31	107.34	55.37	40.67
WFS2T3	02/20/2014	77	120.82	69.78	40.92	52.23	68.07	106.5	55.68	43.63
WFS2T3	02/20/2014	78	121.11	69.78	43.82	52.52	67.76	104.41	55.81	45.99
WFS2T3	02/20/2014	79	120.73	69.75	46.22	52.72	67.71	102.58	55.83	48.08
WFS2T3	02/20/2014	80	121.06	69.7	48.15	52.72	67.71	100.62	56.08	53.45
WFS2T3	02/20/2014	81	121.16	69.75	48.15	52.97	67.78	98.79	56.35	53.72
WFS2T3	02/20/2014	82	121.18	69.8	48.17	52.93	68.36	97.81	56.39	53.68
WFS2T3	02/20/2014	83	120.46	69.82	48.1	52.78	67.78	95.43	50.84	47.71
WFS2T3	02/20/2014	84	121.04	69.7	48.13	52.93	68	93.87	44.54	40.38
WFS2T3	02/20/2014	85	121.09	69.73	48.21	52.95	67.76	92.43	37.38	34.94
WFS2T3	02/20/2014	86	120.51	69.75	48.13	52.76	67.81	91.57	32.82	30.67
WFS2T3	02/20/2014	87	120.42	69.73	48.11	52.72	67.71	90.58	27.94	26.01
WFS2T3	02/20/2014	88	121.11	69.78	48.17	52.72	67.71	90.37	24.64	22.94
WFS2T3	02/20/2014	89	121.14	69.8	48.17	52.78	67.45	90.08	21.79	19.61
WFS2T3	02/20/2014	90	121.09	69.73	48.17	52.7	68	89.12	18.28	17.13
WFS2T3	02/20/2014	91	120.46	69.78	48.13	52.74	67.71	88.83	16.24	15.08
WFS2T3	02/20/2014	92	120.46	69.7	48.15	52.72	68.6	88.5	13.54	12.65

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		Interval	T_WS_H	T_WS_C	P_WS_H	P_WS_C	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS2T3	02/20/2014	93	120.51	69.75	48.13	52.78	68.38	88.98	11.91	10.89
WFS2T3	02/20/2014	94	120.46	69.7	48.15	52.74	68.67	88.59	10.04	9.44
WFS2T3	02/20/2014	95	120.49	69.73	48.13	52.76	68.05	88.52	9.07	8.28
WFS2T3	02/20/2014	96	120.42	69.7	48.15	52.68	68.31	88.21	7.99	7.08
WFS2T3	02/20/2014	97	121.06	69.75	48.21	52.74	67.78	88.3	6.79	6.38
WFS2T3	02/20/2014	98	120.54	69.8	48.15	52.78	68.1	88.3	6.17	5.63
WFS2T3	02/20/2014	99	120.58	69.7	48.13	52.7	68.02	88.02	5.36	5.03
WFS2T3	02/20/2014	100	120.51	69.78	48.15	52.76	67.98	87.99	4.91	4.47
WFS2T3	02/20/2014	101	120.56	69.82	48.1	52.79	68.7	87.99	4.47	3.93
WFS2T3	02/20/2014	102	120.54	69.78	48.13	52.76	68.12	88.02	3.96	3.71
WFS2T3	02/20/2014	103	120.49	69.75	48.1	52.76	69.01	87.99	3.73	3.23
WFS2T3	02/20/2014	104	120.51	69.7	48.23	52.7	68.29	87.68	3.25	2.96
WFS2T3	02/20/2014	105	120.46	69.73	48.13	52.7	68.34	87.63	2.92	2.71
WFS2T3	02/20/2014	106	120.44	69.75	48.17	52.72	68.36	87.66	2.55	2.3
WFS2T3	02/20/2014	107	120.54	69.8	48.1	52.76	68.36	87.15	2.55	2.26
WFS2T3	02/20/2014	108	120.25	69.73	46.01	52.74	68.36	87.78	2.59	2.34
WFS2T3	02/20/2014	109	120.22	69.78	29.41	52.74	68.31	87.37	2.28	2.03
WFS2T3	02/20/2014	110	120.46	69.7	19.11	52.7	68.31	87.34	1.99	1.78
WFS2T3	02/20/2014	111	120.56	69.78	11.37	52.74	68.34	87.42	1.84	1.86
WFS2T3	02/20/2014	112	120.46	69.73	6.81	52.72	68.36	86.82	1.8	1.49
WFS2T3	02/20/2014	113	120.82	69.8	3.67	52.81	68.41	86.82	1.82	1.59
WFS2T3	02/20/2014	114	120.82	69.8	2.03	52.72	68.36	86.86	1.61	1.33
WFS2T3	02/20/2014	115	121.16	69.75	1.3	52.78	68.67	86.84	1.57	1.33
WFS2T3	02/20/2014	116	121.11	69.75	1.04	52.72	68.07	86.82	1.37	1.33
WFS2T3	02/20/2014	117	121.09	69.7	1.04	52.7	68.02	86.14	1.3	1.26
WFS2T3	02/20/2014	118	121.09	69.8	1.06	52.72	68.65	86.14	1.3	1.01
WFS2T3	02/20/2014	119	121.11	69.73	1.06	52.74	68	86.17	1.33	1.06
WFS2T3	02/20/2014	120	121.11	69.73	0.83	52.78	68.62	85.9	1.35	1.06
WFS2T3	02/20/2014	121	121.09	69.78	0.89	52.78	68.7	86.24	1.12	1.1
WFS2T3	02/20/2014	122	121.09	69.7	0.81	52.7	68.7	85.9	1.06	1.02
WFS2T3	02/20/2014	123	121.66	69.68	0.62	52.7	68.6	85.83	1.06	1.02

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		Interval	T_WS_H	T_WS_C	P_WS_H	P_WS_C	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS2T3	02/20/2014	124	121.09	69.78	0.64	52.72	68.65	85.88	1.06	0.99
WFS2T3	02/20/2014	125	121.11	69.7	0.6	52.72	67.98	85.23	1.02	0.81
WFS2T3	02/20/2014	126	121.02	69.7	0.56	52.68	68.6	85.23	1.02	0.79
WFS2T3	02/20/2014	127	121.69	69.75	0.37	52.78	68.1	85.35	1.1	0.85
WFS2T3	02/20/2014	128	121.69	69.82	0.31	52.76	68.7	85.33	1.12	0.91
WFS2T3	02/20/2014	129	121.71	69.75	0.33	52.79	68.7	85.33	1.12	0.89
WFS2T3	02/20/2014	130	121.69	69.8	0.39	52.72	68.67	84.73	1.12	0.83
WFS2T3	02/20/2014	131	121.64	69.8	0.35	52.7	68.7	84.63	1.1	0.81
WFS2T3	02/20/2014	132	121.16	69.78	0.35	52.72	68.65	84.73	1.14	0.91
WFS2T3	02/20/2014	133	121.11	69.75	0.33	52.76	68.67	84.68	0.89	0.87
WFS2T3	02/20/2014	134	121.71	69.8	0.31	52.76	68.67	84.68	0.91	0.85
WFS2T3	02/20/2014	135	121.74	69.73	0.29	52.78	68.05	84.39	0.87	0.87
WFS2T3	02/20/2014	136	121.69	69.78	0.12	52.72	68.07	84.32	0.87	0.81
WFS2T3	02/20/2014	137	121.66	69.8	0.33	52.79	68.62	84.66	0.91	0.83
WFS2T3	02/20/2014	138	121.74	69.75	0.35	52.76	68.65	84.46	0.89	0.87
WFS2T3	02/20/2014	139	121.69	69.75	0.1	52.76	68.7	84.39	0.91	0.81
WFS2T3	02/20/2014	140	121.21	69.85	0.1	52.52	68.7	84.39	0.93	0.91
WFS2T3	02/20/2014	141	121.66	69.75	0.1	52.54	68.65	84.42	0.87	0.85
WFS2T3	02/20/2014	142	121.71	69.8	0.17	52.52	68.12	84.49	0.87	0.89
WFS2T3	02/20/2014	143	121.78	69.8	0.1	52.49	68.72	83.82	0.87	0.85
WFS2T3	02/20/2014	144	121.66	69.7	-0.12	52.23	68.02	83.65	0.87	0.56
WFS2T3	02/20/2014	145	121.06	69.78	-0.31	52.27	68.62	83.82	0.83	0.75
WFS2T3	02/20/2014	146	121.69	69.78	-0.39	52.27	68.05	83.82	0.89	0.85
WFS2T3	02/20/2014	147	121.74	69.78	-0.62	52.04	68.65	83.24	0.93	0.89
WFS2T3	02/20/2014	148	121.71	69.8	-0.58	52.02	68.65	83.22	0.91	0.81
WFS2T3	02/20/2014	149	121.06	69.68	-0.93	52	68.6	83.14	0.79	0.83
WFS2T3	02/20/2014	150	121.06	69.73	-0.81	52	68.62	83.17	0.81	0.58
WFS2T3	02/20/2014	151	121.59	69.73	-0.91	51.98	68.62	83.17	0.87	0.58
WFS2T3	02/20/2014	152	121.66	69.73	-0.87	51.73	68.62	82.57	0.83	0.6
WFS2T3	02/20/2014	153	121.66	69.7	-0.83	51.71	68.65	82.59	0.81	0.81
WFS2T3	02/20/2014	154	121.09	69.73	-1.04	51.73	67.98	83.1	0.87	0.54

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		Interval	T_WS_H	T_WS_C	P_WS_H	P_WS_C	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS2T3	02/20/2014	155	121.11	69.78	-1.06	51.46	67.98	83.17	0.87	0.85
WFS2T3	02/20/2014	156	121.06	69.7	-1.04	51.48	67.98	83.22	0.81	0.58
WFS2T3	02/20/2014	157	121.06	69.75	-1.1	51.46	68.02	82.59	0.85	0.54
WFS2T3	02/20/2014	158	121.14	69.7	-1.08	51.73	68.58	82.59	0.81	0.6
WFS2T3	02/20/2014	159	121.09	69.68	-1.1	51.73	68.5	82.57	0.87	0.56
WFS2T3	02/20/2014	160	121.14	69.75	-0.87	51.75	68.58	82.57	0.89	0.58
WFS2T3	02/20/2014	161	121.11	69.73	-0.77	51.73	68.62	82.57	0.83	0.62
WFS2T3	02/20/2014	162	121.04	69.7	-0.85	51.69	68.6	82.23	0.79	0.56
WFS2T3	02/20/2014	163	121.11	69.44	-0.81	51.83	68.1	82.28	0.93	0.62
WFS2T3	02/20/2014	164	121.09	69.68	-0.85	51.77	68.65	82.64	0.83	0.56
WFS2T3	02/20/2014	165	121.09	69.7	-0.87	51.54	67.98	82.26	0.83	0.54
WFS2T3	02/20/2014	166	121.11	69.78	-0.83	51.54	68.72	82.3	0.91	0.6
WFS2T3	02/20/2014	167	121.11	69.39	-0.85	51.5	68	82.28	0.81	0.56
WFS2T3	02/20/2014	168	121.11	69.73	-0.85	51.44	68.58	82.21	0.77	0.6
WFS2T3	02/20/2014	169	121.04	69.66	-1.1	51.27	68.62	82.23	0.87	0.6
WFS2T3	02/20/2014	170	121.14	69.73	-1.06	51.29	68.65	82.35	0.83	0.62
WFS2T3	02/20/2014	171	121.14	69.8	-1.06	51.32	68.62	82.38	0.87	0.64
WFS2T3	02/20/2014	172	121.11	69.75	-1.01	51.29	68.7	81.87	0.87	0.6
WFS2T3	02/20/2014	173	121.14	69.49	-1.08	51.05	68.05	81.75	0.85	0.62
WFS2T3	02/20/2014	174	121.21	69.42	-1.12	51.05	68.65	82.35	0.85	0.62
WFS2T3	02/20/2014	175	121.16	70.06	-1.08	51.02	68.02	82.3	0.89	0.62
WFS2T3	02/20/2014	176	121.16	70.11	-1.1	51.07	68.7	81.78	0.83	0.64
WFS2T3	02/20/2014	177	121.04	69.42	-1.04	50.8	68.6	81.66	0.79	0.56
WFS2T3	02/20/2014	178	121.06	69.75	-1.04	50.76	68.7	81.73	0.87	0.54
WFS2T3	02/20/2014	179	121.11	70.04	-0.99	50.78	68.65	81.68	0.83	0.58
WFS2T3	02/20/2014	180	121.06	70.02	-1.04	50.78	68.65	81.66	0.81	0.54
WFS2T3	02/20/2014	181	121.09	70.06	-1.08	50.84	68.65	81.7	0.85	0.58
WFS2T3	02/20/2014	182	121.11	70.02	-1.06	50.78	68.58	81.68	0.83	0.6
WFS2T3	02/20/2014	183	121.06	69.99	-1.04	50.51	68.6	81.03	0.81	0.56
WFS2T3	02/20/2014	184	121.09	69.42	-1.14	50.57	68.07	81.66	0.83	0.56
WFS2T3	02/20/2014	185	121.21	69.51	-1.06	50.59	68.72	81.75	0.89	0.66

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		Interval	T_WS_H	T_WS_C	P_WS_H	P_WS_C	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS2T3	02/20/2014	186	121.16	70.06	-1.04	50.61	68.05	81.18	0.91	0.62
WFS2T3	02/20/2014	187	121.14	70.04	-0.97	50.59	68.67	81.08	0.89	0.6
WFS2T3	02/20/2014	188	121.16	69.42	-1.06	50.3	68.62	81.06	0.85	0.62
WFS2T3	02/20/2014	189	121.18	70.09	-1.04	50.32	68.67	81.13	0.87	0.64
WFS2T3	02/20/2014	190	121.18	70.02	-1.01	50.57	68.6	81.1	0.81	0.62
WFS2T3	02/20/2014	191	121.14	70.09	-1.1	50.63	68.72	81.15	0.87	0.62
WFS2T3	02/20/2014	192	121.09	69.39	-1.04	50.55	68.02	81.13	0.81	0.64
WFS2T3	02/20/2014	193	121.04	70.04	-1.04	50.8	68.05	81.03	0.85	0.54
WFS2T3	02/20/2014	194	121.09	70.04	-1.02	50.82	68	81.1	0.85	0.62
WFS2T3	02/20/2014	195	120.46	69.44	-1.06	50.71	68.1	81.06	0.85	0.56
WFS2T3	02/20/2014	196	120.51	70.04	-1.01	51.03	68.67	80.53	0.85	0.62
WFS2T3	02/20/2014	197	120.51	69.73	-1.01	51.27	68.6	80.48	0.83	0.54
WFS2T3	02/20/2014	198	120.51	69.46	-1.06	51.29	68.58	81.15	0.91	0.6
WFS2T3	02/20/2014	199	121.06	69.78	-1.08	51.25	68.67	81.06	0.85	0.58
WFS2T3	02/20/2014	200	120.54	69.8	-1.06	51.54	68.67	81.13	0.85	0.68
WFS2T3	02/20/2014	201	121.06	69.7	-1.06	51.5	67.98	80.5	0.81	0.58
WFS2T3	02/20/2014	202	120.44	69.75	-1.1	51.56	68.46	80.55	0.83	0.54
WFS2T3	02/20/2014	203	120.56	69.78	-1.08	51.98	68.1	80.53	0.89	0.6
WFS2T3	02/20/2014	204	120.54	69.8	-1.06	52.52	68.65	80.55	0.89	0.64
WFS2T3	02/20/2014	205	120.49	69.8	-1.01	52.78	68.02	81.1	0.89	0.6
WFS2T3	02/20/2014	206	120.54	69.78	-1.08	52.79	68.72	80.53	0.87	0.62
WFS2T3	02/20/2014	207	120.54	69.82	-1.08	52.78	68.62	80.55	0.89	0.64
WFS2T3	02/20/2014	208	120.49	69.78	-1.1	52.78	68.67	80.53	0.91	0.6
WFS2T3	02/20/2014	209	120.49	69.7	-1.12	52.74	68.58	80.5	0.87	0.56
WFS2T3	02/20/2014	210	120.44	69.68	-1.06	52.72	68.58	80.5	0.79	0.56
WFS2T3	02/20/2014	211	120.44	69.75	-1.1	52.72	68.05	80.48	0.83	0.52
WFS2T3	02/20/2014	212	120.51	69.7	-1.01	52.7	68.62	80.53	0.79	0.6
WFS2T3	02/20/2014	213	120.46	69.66	-1.12	52.68	68	80.48	0.79	0.5
WFS2T3	02/20/2014	214	120.46	69.7	-1.1	52.72	68.1	80.5	0.85	0.54
WFS2T3	02/20/2014	215	120.49	69.73	-1.12	52.7	68.62	80.53	0.83	0.62
WFS2T3	02/20/2014	216	120.56	69.73	-1.06	52.79	68.55	80.58	0.91	0.62

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		Interval	T_WS_H	T_WS_C	P_WS_H	P_WS_C	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS2T3	02/20/2014	217	120.46	69.78	-1.1	52.76	68.67	79.88	0.79	0.5
WFS2T3	02/20/2014	218	120.51	69.66	-1.1	52.68	68.65	80.48	0.83	0.56
WFS2T3	02/20/2014	219	120.44	69.68	-1.08	52.7	68.6	79.9	0.85	0.54
WFS2T3	02/20/2014	220	120.51	69.78	-1.08	52.7	68.65	80.5	0.85	0.54

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Data from Water Flow Method Scenario 1, Test 3

	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS1T3	02/20/2014	1	82.59	80.53	55.33	55.37	72.85	72.7	58.75	56.04
WFS1T3	02/20/2014	2	82.59	80.48	55.37	55.33	72.8	72.75	58.67	56.1
WFS1T3	02/20/2014	3	83.12	80.46	55.33	55.37	72.82	72.68	58.65	56.02
WFS1T3	02/20/2014	4	82.57	80.55	55.31	55.41	72.8	72.75	58.71	56.06
WFS1T3	02/20/2014	5	82.59	80.43	55.35	55.31	72.85	72.75	58.65	56.1
WFS1T3	02/20/2014	6	82.54	80.53	55.33	55.35	72.82	72.68	58.67	56.06
WFS1T3	02/20/2014	7	82.62	80.43	55.42	55.35	72.78	72.82	58.75	56.1
WFS1T3	02/20/2014	8	82.64	80.53	55.39	55.41	72.78	72.78	58.77	56.12
WFS1T3	02/20/2014	9	82.59	80.5	55.35	55.37	72.82	72.78	58.75	56.02
WFS1T3	02/20/2014	10	82.57	80.48	55.37	55.37	72.78	72.73	58.75	56.06
WFS1T3	02/20/2014	11	82.69	80.55	55.35	55.31	72.82	72.7	58.65	56.08
WFS1T3	02/20/2014	12	82.62	80.58	55.33	55.37	72.82	72.73	58.69	56.06
WFS1T3	02/20/2014	13	82.64	80.46	55.41	55.42	72.75	72.75	58.75	56
WFS1T3	02/20/2014	14	82.62	80.46	55.35	55.41	72.75	72.82	58.75	56.1
WFS1T3	02/20/2014	15	82.54	80.55	55.37	55.33	72.87	72.68	58.67	56.31
WFS1T3	02/20/2014	16	82.62	80.48	55.41	55.42	72.46	72.82	59	56.37
WFS1T3	02/20/2014	17	82.64	80.41	55.37	55.39	72.44	72.82	59	56.31
WFS1T3	02/20/2014	18	82.71	80.46	55.41	55.41	72.46	72.75	58.94	56.14
WFS1T3	02/20/2014	19	82.62	80.43	55.44	55.37	72.49	72.8	59	56.02
WFS1T3	02/20/2014	20	82.66	80.43	55.33	55.35	72.46	72.75	58.81	56.14
WFS1T3	02/20/2014	21	82.59	80.55	55.35	55.33	72.85	72.7	58.69	56.04
WFS1T3	02/20/2014	22	82.64	80.46	55.35	55.39	72.8	72.66	58.73	56.06
WFS1T3	02/20/2014	23	82.69	80.48	55.33	55.39	72.73	72.82	58.79	56.16
WFS1T3	02/20/2014	24	82.66	80.43	55.35	55.41	72.78	72.8	58.75	56.12
WFS1T3	02/20/2014	25	82.66	80.5	55.41	55.41	72.75	72.78	58.73	56.08
WFS1T3	02/20/2014	26	82.62	80.46	55.35	55.41	72.82	72.7	58.71	56.1
WFS1T3	02/20/2014	27	82.74	80.48	51.31	55.41	72.73	72.75	58.71	56.1
WFS1T3	02/20/2014	28	82.59	80.55	51.02	55.39	72.82	72.73	58.5	55.79
WFS1T3	02/20/2014	29	82.59	80.53	50.82	55.37	72.82	72.75	58.46	55.85
WFS1T3	02/20/2014	30	82.54	80.53	50.55	55.33	72.8	72.68	58.38	55.79

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS1T3	02/20/2014	31	82.62	80.5	50.55	55.39	72.2	72.7	58.48	55.81
WFS1T3	02/20/2014	32	82.66	80.41	50.09	55.39	72.75	72.8	58.6	55.85
WFS1T3	02/20/2014	33	83.84	80.53	49.91	55.41	72.8	72.75	58.52	55.91
WFS1T3	02/20/2014	34	85.33	80.46	49.95	55.39	72.75	72.8	58.56	55.83
WFS1T3	02/20/2014	35	86.17	80.48	49.57	55.35	72.82	72.75	58.44	55.79
WFS1T3	02/20/2014	36	89.41	80.46	49.33	55.35	72.85	72.7	58.44	55.79
WFS1T3	02/20/2014	37	92.19	80.43	49.18	55.37	72.8	72.75	58.5	55.85
WFS1T3	02/20/2014	38	93.63	80.53	49.1	55.35	72.22	72.8	58.54	55.81
WFS1T3	02/20/2014	39	95.72	80.53	48.87	55.35	72.8	72.06	58.44	55.85
WFS1T3	02/20/2014	40	96.94	80.46	48.93	55.37	72.7	72.82	58.54	55.87
WFS1T3	02/20/2014	41	98.82	80.55	48.66	55.37	72.85	72.75	58.6	55.85
WFS1T3	02/20/2014	42	100.52	80.46	48.66	55.29	72.75	72.7	58.5	55.89
WFS1T3	02/20/2014	43	101.38	80.48	48.66	55.37	72.8	72.82	58.48	55.85
WFS1T3	02/20/2014	44	103.23	80.48	48.85	55.41	72.75	72.73	58.58	55.91
WFS1T3	02/20/2014	45	104	80.58	48.87	55.31	72.3	72.75	58.46	55.83
WFS1T3	02/20/2014	46	104.62	80.48	48.89	55.42	72.85	72.73	58.5	55.83
WFS1T3	02/20/2014	47	105.87	80.5	48.85	55.41	72.8	72.34	58.52	55.81
WFS1T3	02/20/2014	48	106.35	80.53	48.87	55.37	72.78	72.7	58.44	55.85
WFS1T3	02/20/2014	49	106.74	80.48	48.91	55.37	72.8	72.73	58.52	55.87
WFS1T3	02/20/2014	50	107.43	80.43	48.91	55.41	72.75	72.85	58.54	55.89
WFS1T3	02/20/2014	51	107.98	80.53	48.89	55.35	72.82	72.78	58.54	55.81
WFS1T3	02/20/2014	52	108.54	80.46	49.08	55.39	72.85	72.68	58.5	55.77
WFS1T3	02/20/2014	53	108.8	80.43	49.06	55.35	72.8	72.75	58.48	55.83
WFS1T3	02/20/2014	54	109.5	80.5	49.18	55.35	72.8	72.78	58.52	55.62
WFS1T3	02/20/2014	55	110.05	80.46	49.1	55.39	72.75	72.78	58.25	55.62
WFS1T3	02/20/2014	56	110.1	80.43	49.16	55.41	72.73	72.75	58.5	55.87
WFS1T3	02/20/2014	57	110.7	80.46	49.16	55.41	72.75	72.78	58.54	55.85
WFS1T3	02/20/2014	58	111.2	80.5	49.31	55.35	72.85	72.73	58.25	55.56
WFS1T3	02/20/2014	59	111.27	80.5	53.16	55.42	72.85	72.2	58.25	55.79
WFS1T3	02/20/2014	60	110.67	80.55	53.47	55.37	72.85	72.44	58.17	55.54
WFS1T3	02/20/2014	61	110.65	80.53	53.43	55.33	72.82	72.73	58.23	55.54

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS1T3	02/20/2014	62	110.65	80.53	53.39	55.35	72.82	72.7	58.21	55.83
WFS1T3	02/20/2014	63	111.3	80.55	53.74	55.39	72.78	72.78	58.25	55.46
WFS1T3	02/20/2014	64	110.65	80.46	53.76	55.35	72.2	72.78	58.31	55.91
WFS1T3	02/20/2014	65	111.27	80.46	53.94	55.37	72.7	72.75	57.55	54.84
WFS1T3	02/20/2014	66	110.72	80.5	53.94	55.39	72.8	72.8	57.57	55.17
WFS1T3	02/20/2014	67	110.7	80.53	54.71	55.39	72.73	72.75	58.77	55.79
WFS1T3	02/20/2014	68	110.72	80.43	54.86	55.37	72.78	72.8	58.75	55.87
WFS1T3	02/20/2014	69	110.7	80.5	55.13	55.42	72.8	72.8	58.71	55.91
WFS1T3	02/20/2014	70	110.6	80.53	55.1	55.37	72.82	72.7	58.71	56.04
WFS1T3	02/20/2014	71	110.94	80.55	55.13	55.35	72.82	72.7	58.67	56.16
WFS1T3	02/20/2014	72	110.89	80.43	55.12	55.35	72.78	72.75	58.67	56.14
WFS1T3	02/20/2014	73	110.62	80.48	55.1	55.37	72.85	72.75	58.75	56.02
WFS1T3	02/20/2014	74	110.62	80.53	55.1	55.35	72.78	72.75	58.69	56.06
WFS1T3	02/20/2014	75	110.58	80.55	55.1	55.37	72.8	72.73	58.69	56.1
WFS1T3	02/20/2014	76	110.65	80.46	55.15	55.39	72.1	72.73	58.75	56.08
WFS1T3	02/20/2014	77	110.65	80.55	55.12	55.42	72.73	72.75	58.71	56.22
WFS1T3	02/20/2014	78	110.67	80.46	55.13	55.39	72.8	72.8	58.75	56.14
WFS1T3	02/20/2014	79	110.65	80.5	55.17	55.41	72.78	72.75	58.75	56.1
WFS1T3	02/20/2014	80	110.67	80.53	55.1	55.35	72.82	72.75	58.69	56.08
WFS1T3	02/20/2014	81	110.7	80.48	55.17	55.41	72.85	72.8	58.73	56.18
WFS1T3	02/20/2014	82	110.05	80.48	55.17	55.35	72.8	72.78	58.71	56.1
WFS1T3	02/20/2014	83	110.05	80.46	55.08	55.42	72.73	72.8	58.77	56.12
WFS1T3	02/20/2014	84	110.07	80.58	54.9	55.41	72.82	72.75	58.75	56.14
WFS1T3	02/20/2014	85	110.34	80.5	51.31	53.9	73.16	72.68	55.58	51.48
WFS1T3	02/20/2014	86	110.02	80.84	48.66	52.72	74.26	73.06	54.84	49.84
WFS1T3	02/20/2014	87	110.05	80.77	47.46	51.98	74.89	73.02	53.39	48.62
WFS1T3	02/20/2014	88	110.41	80.46	46.26	50.59	74.86	72.75	52.52	47.21
WFS1T3	02/20/2014	89	109.76	80.46	45.06	50.05	75.94	72.8	52.02	46.28
WFS1T3	02/20/2014	90	110.1	80.5	44.58	49.86	75.78	72.8	51.77	45.79
WFS1T3	02/20/2014	91	109.66	80.5	38.87	50.59	75.44	72.08	55.85	26.96
WFS1T3	02/20/2014	92	110.02	79.9	27.87	51.29	75.78	73.38	54.65	22.65

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS1T3	02/20/2014	93	110.02	79.35	27.48	51.44	75.75	73.35	54.86	22.43
WFS1T3	02/20/2014	94	109.78	79.26	27.5	51.77	75.73	75.13	55.17	22.45
WFS1T3	02/20/2014	95	109.74	78.61	27.48	51.5	75.15	77.19	55.12	22.47
WFS1T3	02/20/2014	96	109.66	78.42	27.42	50.98	75.1	80.48	54.4	22.41
WFS1T3	02/20/2014	97	109.71	78.42	27.4	50.55	74.82	82.88	53.9	22.18
WFS1T3	02/20/2014	98	109.81	77.74	27.46	50.59	74.84	86.82	53.88	22.24
WFS1T3	02/20/2014	99	109.74	77.77	27.52	50.8	74.84	89.77	53.86	22.26
WFS1T3	02/20/2014	100	109.74	77.74	27.6	51.05	74.82	92.12	54.44	22.45
WFS1T3	02/20/2014	101	109.78	77.17	27.69	51.56	74.02	95.14	54.94	22.49
WFS1T3	02/20/2014	102	109.78	77.19	27.93	52.04	73.93	96.61	55.12	23.19
WFS1T3	02/20/2014	103	109.71	77.31	33.24	51.25	73.45	98.67	53.16	34.4
WFS1T3	02/20/2014	104	109.45	76.57	33.92	50.55	73.11	98.96	52.23	35.41
WFS1T3	02/20/2014	105	109.42	76.33	34.93	50.05	72.51	99.03	51.92	36.34
WFS1T3	02/20/2014	106	109.71	76.21	35.72	49.87	71.89	99.61	51.65	36.84
WFS1T3	02/20/2014	107	109.76	76.21	36.38	50.07	71.53	99.32	51.83	37.81
WFS1T3	02/20/2014	108	109.78	75.68	37.11	50.34	70.64	98.77	52.27	38.35
WFS1T3	02/20/2014	109	109.4	75.2	37.83	52.47	71.34	98.07	53.12	39.14
WFS1T3	02/20/2014	110	110.07	75.15	40.21	52.18	71.02	97.14	55.58	41.67
WFS1T3	02/20/2014	111	109.71	74.62	43.13	52.7	71.02	95.98	56.04	44.27
WFS1T3	02/20/2014	112	110.02	73.98	45.47	52.74	71.05	94.78	56.08	46.68
WFS1T3	02/20/2014	113	109.71	73.4	47.57	52.95	70.95	93.34	56.31	48.89
WFS1T3	02/20/2014	114	110.02	73.33	49.37	52.68	70.45	92.07	56.31	50.73
WFS1T3	02/20/2014	115	109.71	73.4	50.76	52.72	70.45	90.3	56.12	51.73
WFS1T3	02/20/2014	116	109.81	73.3	51.77	52.78	69.75	89.24	56.16	52.56
WFS1T3	02/20/2014	117	109.78	73.06	52.23	52.79	70.42	88.95	56.39	53.28
WFS1T3	02/20/2014	118	109.74	73.02	52.58	52.68	69.8	87.06	56.12	53.49
WFS1T3	02/20/2014	119	109.78	73.06	52.47	52.47	70.4	86.19	55.77	53.47
WFS1T3	02/20/2014	120	110.29	73.09	52.5	52.76	70.42	84.87	56.06	53.41
WFS1T3	02/20/2014	121	110.34	72.42	52.68	52.74	70.4	84.99	56.06	53.39
WFS1T3	02/20/2014	122	110.34	72.39	51.5	52.52	70.11	84.13	55.56	52.76
WFS1T3	02/20/2014	123	109.11	73.09	37.15	52.47	70.14	82.54	55.58	28.43

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS1T3	02/20/2014	124	109.98	72.39	27.94	51.96	70.09	83.46	55.39	22.66
WFS1T3	02/20/2014	125	109.76	72.8	27.42	50.98	69.54	87.42	54.59	22.47
WFS1T3	02/20/2014	126	109.74	72.7	27.54	50.61	70.09	88.28	53.9	22.49
WFS1T3	02/20/2014	127	110	72.75	27.46	49.86	69.87	90.25	53.14	22.14
WFS1T3	02/20/2014	128	110.1	72.08	27.54	49.14	69.73	93.66	52.5	22.22
WFS1T3	02/20/2014	129	110.12	72.1	27.44	48.89	69.75	95.24	52.02	22.22
WFS1T3	02/20/2014	130	109.76	72.06	27.52	48.91	69.2	97.28	52.02	22.22
WFS1T3	02/20/2014	131	109.71	72.13	27.48	49.1	69.2	98.96	52.47	22.2
WFS1T3	02/20/2014	132	109.71	72.15	27.48	49.57	69.51	100.52	52.74	22.39
WFS1T3	02/20/2014	133	109.95	72.15	27.48	49.8	69.27	101.62	53.18	22.12
WFS1T3	02/20/2014	134	110.02	72.78	27.42	49.8	69.85	102.54	53.1	22.39
WFS1T3	02/20/2014	135	109.98	72.27	31.12	50.07	69.25	105.22	53.86	31.56
WFS1T3	02/20/2014	136	110.02	72.13	34.93	50.82	69.22	103.74	54.17	36.8
WFS1T3	02/20/2014	137	109.78	72.15	37.54	50.84	69.42	103.54	54.46	39.03
WFS1T3	02/20/2014	138	110.14	72.68	40.46	50.8	68.89	103.28	54.44	41.46
WFS1T3	02/20/2014	139	110.05	72.08	42.91	51.05	68.94	103.11	54.38	44.34
WFS1T3	02/20/2014	140	110.1	72.1	44.81	51.03	68.91	101.7	54.48	46.06
WFS1T3	02/20/2014	141	110.41	72.73	46.95	50.84	68.94	100.52	54.42	48.19
WFS1T3	02/20/2014	142	110.05	72.1	48.42	50.8	68.89	98.79	54.44	49.39
WFS1T3	02/20/2014	143	110.07	72.08	49.62	50.86	68.89	97.57	54.44	50.55
WFS1T3	02/20/2014	144	109.71	72.15	50.03	50.78	68.98	96.27	54.36	51.31
WFS1T3	02/20/2014	145	109.76	72.78	50.63	50.82	68.96	94.52	54.46	51.54
WFS1T3	02/20/2014	146	109.78	71.79	50.84	51.29	68.86	93.68	54.61	51.81
WFS1T3	02/20/2014	147	110.43	71.79	51.31	51.56	68.94	92.53	54.86	52.04
WFS1T3	02/20/2014	148	110.34	71.79	51.29	51.5	68.96	91.81	55.13	52.45
WFS1T3	02/20/2014	149	109.76	72.37	51.5	51.48	68.96	91.23	55.12	52.52
WFS1T3	02/20/2014	150	109.83	71.82	51.56	51.81	68.96	90.46	55.42	52.56
WFS1T3	02/20/2014	151	109.76	71.79	51.56	51.81	68.91	90.39	55.41	52.76
WFS1T3	02/20/2014	152	109.76	71.86	51.75	52.02	68.96	89.74	55.33	52.76
WFS1T3	02/20/2014	153	110.31	72.46	51.79	51.96	68.98	89.74	55.35	52.74
WFS1T3	02/20/2014	154	109.69	71.79	51.96	51.98	68.89	89.14	55.33	52.7

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS1T3	02/20/2014	155	109.78	71.79	52.04	52.04	68.89	89.22	55.39	52.76
WFS1T3	02/20/2014	156	109.74	71.79	52.02	52.02	68.98	89.17	55.41	52.74
WFS1T3	02/20/2014	157	109.78	71.82	52.08	52	69.46	88.9	55.39	52.97
WFS1T3	02/20/2014	158	109.74	71.79	52	52.2	68.91	88.83	55.6	53.2
WFS1T3	02/20/2014	159	109.78	71.82	52.02	52.25	68.96	88.3	55.85	53.22
WFS1T3	02/20/2014	160	109.71	71.86	52.21	52.5	68.96	88.52	55.83	53.18
WFS1T3	02/20/2014	161	109.71	71.91	52.47	52.49	68.98	88.23	55.85	53.2
WFS1T3	02/20/2014	162	109.69	71.86	52.5	52.43	69.06	88.23	55.83	53.36
WFS1T3	02/20/2014	163	109.78	71.84	52.45	52.47	69.2	88.21	55.83	53.39
WFS1T3	02/20/2014	164	109.71	71.82	52.52	52.45	69.42	88.21	55.87	53.47
WFS1T3	02/20/2014	165	109.78	72.39	52.52	52.45	69.44	88.3	55.77	53.47
WFS1T3	02/20/2014	166	109.74	71.82	52.47	52.49	69.46	87.63	55.83	53.43
WFS1T3	02/20/2014	167	109.78	71.84	52.52	52.76	68.84	87.68	56.12	53.47
WFS1T3	02/20/2014	168	109.78	71.77	52.74	52.97	68.94	87.78	56.33	53.72
WFS1T3	02/20/2014	169	109.21	71.84	34.02	53.2	68.91	87.1	56.62	37.4
WFS1T3	02/20/2014	170	109.47	71.84	20.48	53.2	69.22	87.32	56.57	22.18
WFS1T3	02/20/2014	171	109.71	71.82	14.54	53.41	69.2	87.03	56.55	17.37
WFS1T3	02/20/2014	172	110	71.86	11.62	53.18	69.22	86.79	56.55	14.72
WFS1T3	02/20/2014	173	109.78	71.74	9.24	52.97	69.39	86.24	56.31	12.43
WFS1T3	02/20/2014	174	110.07	71.82	8.03	52.74	68.94	85.23	56.39	11.45
WFS1T3	02/20/2014	175	110.05	71.82	7.14	52.76	68.91	84.7	56.14	10.25
WFS1T3	02/20/2014	176	110.02	71.19	6.4	52.54	68.89	83.89	55.91	9.51
WFS1T3	02/20/2014	177	110.41	71.22	5.69	52.5	68.96	82.38	55.83	8.82
WFS1T3	02/20/2014	178	110.34	71.82	5.26	52.52	68.91	81.78	55.6	8.32
WFS1T3	02/20/2014	179	110.38	71.84	4.51	52.52	69.01	81.46	55.85	8.06
WFS1T3	02/20/2014	180	110.29	71.82	3.96	52.7	68.94	80.5	55.81	7.06
WFS1T3	02/20/2014	181	109.66	71.77	3.33	52.74	68.91	79.66	56.1	6.36
WFS1T3	02/20/2014	182	110.02	71.89	2.48	52.7	68.98	79.02	56.08	5.65
WFS1T3	02/20/2014	183	109.21	71.77	1.8	52.54	68.91	78.18	55.87	5.16
WFS1T3	02/20/2014	184	108.54	71.82	1.06	52.21	68.89	78.08	55.6	4.41
WFS1T3	02/20/2014	185	108.06	71.22	0.85	52.06	68.84	76.95	55.39	4.24

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS1T3	02/20/2014	186	107.43	71.77	0.87	52.04	68.94	76.74	55.41	4
WFS1T3	02/20/2014	187	107.07	71.86	0.58	51.92	69.01	76.71	55.33	3.67
WFS1T3	02/20/2014	188	105.85	71.82	0.31	51.94	68.98	76.64	55.42	3.73
WFS1T3	02/20/2014	189	105.27	71.22	0.35	52.49	68.96	75.78	55.56	3.71
WFS1T3	02/20/2014	190	104.96	71.26	0.35	52.5	68.94	76.02	55.83	3.75
WFS1T3	02/20/2014	191	104.43	71.82	0.35	52.54	68.89	75.8	55.83	3.81
WFS1T3	02/20/2014	192	103.78	71.77	0.37	52.5	69.44	75.22	55.81	3.81
WFS1T3	02/20/2014	193	103.26	71.24	0.43	52.52	68.94	75.15	55.64	3.79
WFS1T3	02/20/2014	194	102.63	71.14	0.37	52.27	68.91	74.6	55.66	3.81
WFS1T3	02/20/2014	195	102.37	71.26	0.37	52.06	68.91	74.53	55.39	3.77
WFS1T3	02/20/2014	196	101.67	71.5	0.31	51.98	68.94	74.55	55.37	3.67
WFS1T3	02/20/2014	197	101.14	71.43	0.39	51.85	68.89	73.93	55.37	3.73
WFS1T3	02/20/2014	198	100.52	71.5	0.39	51.87	68.94	73.9	55.17	3.77
WFS1T3	02/20/2014	199	100.23	71.53	0.39	51.61	68.94	73.95	55.13	3.77
WFS1T3	02/20/2014	200	99.58	71.55	0.31	51.71	68.94	73.93	55.41	3.81
WFS1T3	02/20/2014	201	98.43	71.55	0.39	51.73	68.96	73.66	55.31	3.64
WFS1T3	02/20/2014	202	97.69	71.5	0.29	51.75	68.34	73.62	55.41	3.62
WFS1T3	02/20/2014	203	97.54	71.55	0.33	51.75	68.96	73.62	55.13	3.67
WFS1T3	02/20/2014	204	96.8	71.53	0.37	51.5	68.94	73.02	55.06	3.65
WFS1T3	02/20/2014	205	96.39	71.48	0.33	51.52	68.96	73.06	55.12	3.71
WFS1T3	02/20/2014	206	96.06	70.9	0.29	51.46	68.98	73.02	55.13	3.73
WFS1T3	02/20/2014	207	95.48	71.58	0.33	51.5	68.34	73.06	55.1	3.73
WFS1T3	02/20/2014	208	94.86	71.5	0.64	51.52	68.91	73.09	55.17	3.71
WFS1T3	02/20/2014	209	94.71	71.46	0.6	51.54	68.31	72.8	55.17	3.81
WFS1T3	02/20/2014	210	94.09	70.95	0.62	51.63	68.98	72.78	55.13	3.75
WFS1T3	02/20/2014	211	93.39	71.55	0.56	51.52	68.98	72.73	55.1	3.73
WFS1T3	02/20/2014	212	93.44	71.58	0.6	51.46	69.03	72.8	55.08	3.69
WFS1T3	02/20/2014	213	92.86	71.5	0.39	51.81	68.55	72.2	55.35	3.75
WFS1T3	02/20/2014	214	92.22	71.22	0.41	52.04	68.29	72.82	55.41	3.69
WFS1T3	02/20/2014	215	92.17	71.22	0.35	52.25	68.89	72.78	55.6	3.67
WFS1T3	02/20/2014	216	91.98	71.26	0.62	52.52	68.36	72.18	55.81	3.71

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS1T3	02/20/2014	217	91.21	71.29	0.52	52.7	68.98	72.2	56.06	3.75
WFS1T3	02/20/2014	218	90.7	71.22	0.62	53.45	68.89	72.25	56.66	3.75
WFS1T3	02/20/2014	219	90.44	71.24	0.6	54.44	68.62	72.22	57.57	3.79
WFS1T3	02/20/2014	220	90.27	70.95	0.56	54.86	68.62	72.18	58.27	3.89
WFS1T3	02/20/2014	221	89.77	70.98	0.56	55.1	68.65	71.53	58.46	3.96
WFS1T3	02/20/2014	222	89.22	70.9	0.62	55.15	68.58	71.6	58.27	3.75
WFS1T3	02/20/2014	223	88.59	70.95	0.56	54.65	68.65	72.1	57.71	3.69
WFS1T3	02/20/2014	224	88.62	71.17	0.62	54.44	68.55	72.06	57.55	3.79
WFS1T3	02/20/2014	225	87.99	71.19	0.58	54.21	68.6	71.62	57.22	3.75
WFS1T3	02/20/2014	226	87.73	71.19	0.62	53.95	68.94	71.62	57.34	3.79
WFS1T3	02/20/2014	227	87.08	70.66	0.6	53.92	68.41	72.2	57.26	3.75
WFS1T3	02/20/2014	228	87.03	71.24	0.6	54.17	68.65	71.55	57.26	3.64
WFS1T3	02/20/2014	229	86.48	71.24	0.62	54.17	68.62	71.55	57.32	3.79
WFS1T3	02/20/2014	230	86.55	71.19	0.62	53.97	68.89	71.58	57.09	3.81
WFS1T3	02/20/2014	231	85.86	70.66	0.58	53.43	68.96	71.55	57.11	3.69
WFS1T3	02/20/2014	232	85.93	71.17	0.66	53.47	68.91	71.6	56.84	3.79
WFS1T3	02/20/2014	233	85.66	71.19	0.64	53.18	68.84	71.58	56.62	3.75
WFS1T3	02/20/2014	234	85.02	70.69	0.58	53.24	68.38	71	56.39	3.75
WFS1T3	02/20/2014	235	85.04	70.88	0.7	52.74	68.31	71.58	56.37	3.73
WFS1T3	02/20/2014	236	84.44	70.69	0.6	52.93	68.98	71.02	56.33	3.69
WFS1T3	02/20/2014	237	84.37	70.66	0.56	53.18	68.34	70.98	56.53	3.67
WFS1T3	02/20/2014	238	84.46	70.59	0.64	53.22	68.89	71.6	56.6	3.77
WFS1T3	02/20/2014	239	84.15	70.57	0.35	53.22	68.31	71.55	56.64	3.77
WFS1T3	02/20/2014	240	84.18	70.59	0.62	53.45	68.34	71	56.66	3.79
WFS1T3	02/20/2014	241	83.53	70.59	0.35	53.26	68.29	71.07	56.6	3.65
WFS1T3	02/20/2014	242	82.93	70.59	0.6	52.93	68.26	71.02	56.31	3.83
WFS1T3	02/20/2014	243	83.02	70.57	0.62	52.93	68.86	70.95	56.31	3.69
WFS1T3	02/20/2014	244	82.98	70.59	0.66	53.2	68.31	71	56.35	3.79
WFS1T3	02/20/2014	245	82.62	70.57	0.6	53.22	68.91	71	56.62	3.69
WFS1T3	02/20/2014	246	82.59	70.64	0.35	53.39	68.41	70.98	56.53	3.67
WFS1T3	02/20/2014	247	82.57	70.66	0.56	53.66	68.34	70.95	57.03	3.73

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS1T3	02/20/2014	248	82.06	70.62	0.62	53.7	68.26	70.93	57.07	3.77
WFS1T3	02/20/2014	249	82.09	70.59	0.62	53.72	68.26	71	57.09	3.81
WFS1T3	02/20/2014	250	81.37	70.66	0.56	53.41	68.98	70.98	56.84	3.71
WFS1T3	02/20/2014	251	81.42	70.66	0.58	53.45	68.41	71.05	56.82	3.75
WFS1T3	02/20/2014	252	81.42	70.64	0.62	53.18	68.36	70.66	56.58	3.73
WFS1T3	02/20/2014	253	81.39	70.66	0.6	52.91	68.36	70.9	56.35	3.69
WFS1T3	02/20/2014	254	80.86	70.98	0.58	52.72	68.36	70.98	56.33	3.77
WFS1T3	02/20/2014	255	80.79	70.33	0.54	52.7	68.36	70.93	56.1	3.69
WFS1T3	02/20/2014	256	80.79	70.33	0.56	52.7	68.36	70.9	56.06	3.73
WFS1T3	02/20/2014	257	80.58	70.95	0.58	52.78	68.34	70.71	56.37	3.81
WFS1T3	02/20/2014	258	80.5	70.98	0.62	52.7	68.36	70.62	56.29	3.65
WFS1T3	02/20/2014	259	79.88	70.98	0.62	52.74	68.34	70.95	56.08	3.75
WFS1T3	02/20/2014	260	79.93	70.35	0.54	52.74	68.38	70.71	55.83	3.75
WFS1T3	02/20/2014	261	79.98	70.93	0.62	52.54	68.26	70.71	55.77	3.73
WFS1T3	02/20/2014	262	79.98	70.95	0.64	52.23	68.34	70.71	55.62	3.71
WFS1T3	02/20/2014	263	79.95	70.38	0.33	52.2	68.94	70.66	55.35	3.77
WFS1T3	02/20/2014	264	79.33	70.35	0.35	52.45	68.34	70.62	55.58	3.65
WFS1T3	02/20/2014	265	79.3	70.69	0.39	52.93	68.34	70.64	56.62	3.65
WFS1T3	02/20/2014	266	79.04	70.64	0.31	53.43	68.36	70.69	56.97	3.79
WFS1T3	02/20/2014	267	79.09	70.64	0.35	53.9	68.34	70.98	57.28	3.73
WFS1T3	02/20/2014	268	79.02	70.59	0.29	54.15	68.07	70.95	57.3	3.65
WFS1T3	02/20/2014	269	79.04	70.59	0.39	53.88	68.29	70.71	57.28	3.81
WFS1T3	02/20/2014	270	79.04	70.64	0.31	53.97	68.96	70.93	57.03	3.65
WFS1T3	02/20/2014	271	78.99	70.4	0.56	53.41	68.98	70.64	56.84	3.69
WFS1T3	02/20/2014	272	78.46	70.35	0.56	53.39	68.38	70.71	56.62	3.96
WFS1T3	02/20/2014	273	78.44	70.35	0.6	53.18	68.31	70.33	56.28	3.93
WFS1T3	02/20/2014	274	78.51	70.59	0.93	52.95	68.29	70.4	56.33	4.16
WFS1T3	02/20/2014	275	78.49	70.26	0.83	52.93	68.29	70.33	56.33	4.24
WFS1T3	02/20/2014	276	77.91	70.33	1.41	52.99	68.31	70.4	56.39	4.68
WFS1T3	02/20/2014	277	78.01	70.33	2.3	52.95	68.31	70.38	56.37	5.2
WFS1T3	02/20/2014	278	78.25	70.26	2.49	52.99	68.29	70.42	56.41	6.15

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
WFS1T3	02/20/2014	279	77.84	70.3	3.48	52.7	68.36	70.62	55.87	6.58
WFS1T3	02/20/2014	280	77.62	70.33	4.22	52.49	68.31	70.66	55.87	7.39
WFS1T3	02/20/2014	281	77.58	70.35	4.91	52.49	68.36	69.99	55.6	8.04
WFS1T3	02/20/2014	282	77.62	70.26	6.11	52.29	68.29	70.4	55.37	9.05
WFS1T3	02/20/2014	283	76.95	70.28	6.85	52.04	68.29	70.38	55.39	9.98
WFS1T3	02/20/2014	284	76.76	70.35	7.95	51.75	68.38	70.38	55.15	10.93
WFS1T3	02/20/2014	285	77.22	70.33	9.22	51.73	68.34	70.35	55.37	12.09
WFS1T3	02/20/2014	286	76.98	70.35	10.15	51.71	68.36	70.66	55.35	13.09
WFS1T3	02/20/2014	287	76.95	69.8	11.87	51.52	68.36	70.38	55.19	14.52
WFS1T3	02/20/2014	288	76.62	69.75	13.36	51.46	68.02	70.35	55.12	15.95
WFS1T3	02/20/2014	289	76.71	70.33	14.85	51.58	68.6	70.11	54.86	17.68
WFS1T3	02/20/2014	290	76.35	70.33	16.65	51.52	68.36	70.11	55.13	19.05
WFS1T3	02/20/2014	291	76.71	70.28	18.68	51.58	68.29	70.42	55.08	21.23
WFS1T3	02/20/2014	292	76.4	69.7	20.85	51.48	68.26	70.71	55.12	23.19
WFS1T3	02/20/2014	293	76.35	70.33	23.38	51.5	68.31	69.75	55.08	25.06
WFS1T3	02/20/2014	294	76.69	70.26	25.82	51.75	68.02	70.71	55.44	28
WFS1T3	02/20/2014	295	76.33	69.8	28.47	51.98	68.1	70.3	55.31	30.05
WFS1T3	02/20/2014	296	76.26	69.82	31.29	52	68.38	70.09	55.44	33.24
WFS1T3	02/20/2014	297	76.3	70.35	34	52.2	68.36	69.73	55.64	35.85
WFS1T3	02/20/2014	298	76.14	70.35	37.59	52.47	68.31	70.06	55.85	38.35
WFS1T3	02/20/2014	299	76.09	70.28	40.26	52.47	68.29	70.33	55.83	41.4
WFS1T3	02/20/2014	300	76.47	70.28	42.64	52.5	68.26	70.14	55.79	44.09
WFS1T3	02/20/2014	301	76.11	70.33	45.81	52.49	68.26	70.4	55.81	46.74

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Data from Eatherton Method Scenario 2, Test 4

	Date	Interval	SV3P_C	SV3P_H	HWS	CWS	SV3T_H	CWSP	SV3T_C	HWSP
EaS2T4	04/17/2014	1	34.71	71.55	89.82	72.4	80.86	54	54.65	33.98
EaS2T4	04/17/2014	2	34.64	72.25	89.77	72.4	80.74	53.9	54.36	33.94
EaS2T4	04/17/2014	3	34.69	72.22	89.77	72.5	80.82	53.9	54.71	33.98
EaS2T4	04/17/2014	4	34.75	71.62	89.84	72.4	80.89	54.2	54.38	33.88
EaS2T4	04/17/2014	5	34.69	72.15	89.77	72.4	80.82	53.9	54.65	33.96
EaS2T4	04/17/2014	6	34.71	71.62	89.82	72.5	80.84	54.1	54.67	33.88
EaS2T4	04/17/2014	7	34.64	72.18	89.74	72.4	80.77	54.1	54.36	33.92
EaS2T4	04/17/2014	8	34.69	72.2	89.82	72.4	80.86	54.2	54.38	33.96
EaS2T4	04/17/2014	9	34.64	72.2	89.84	72.4	80.79	54.2	54.42	33.86
EaS2T4	04/17/2014	10	34.69	72.03	89.26	72.4	80.94	54.2	54.69	33.9
EaS2T4	04/17/2014	11	34.58	71.62	89.79	72.5	80.82	54.4	54.38	33.75
EaS2T4	04/17/2014	12	29.43	72.2	89.38	72.4	80.5	53.5	54.57	27.4
EaS2T4	04/17/2014	13	27.54	71.58	90.18	72.4	80.55	53.2	54.69	26.49
EaS2T4	04/17/2014	14	27.67	72.25	90.34	72.2	80.46	52.7	54.44	26.75
EaS2T4	04/17/2014	15	27.73	72.27	91.02	72.8	80.79	51.9	54.4	27.02
EaS2T4	04/17/2014	16	27.69	72.22	91.54	72.2	80.79	51.5	54.4	27.04
EaS2T4	04/17/2014	17	27.75	71.53	91.81	72.1	80.84	51.5	54.38	26.96
EaS2T4	04/17/2014	18	27.94	71.58	92.48	72.1	80.84	51.5	54.32	27
EaS2T4	04/17/2014	19	28.02	71.6	93.18	72.1	80.94	52.1	54.44	27.21
EaS2T4	04/17/2014	20	28.22	71.6	93.78	72.8	81.37	52.5	54.65	27.44
EaS2T4	04/17/2014	21	28.2	72.18	94.33	72.1	82.04	53	54.65	27.4
EaS2T4	04/17/2014	22	28.51	72.18	94.66	72.5	81.78	53.2	54.34	27.69
EaS2T4	04/17/2014	23	28.43	72.18	95.22	72.2	82.26	52.9	54.46	27.46
EaS2T4	04/17/2014	24	28.2	71.58	95.74	72.1	82.93	52.8	54.44	27.46
EaS2T4	04/17/2014	25	28.16	71.62	95.96	72.1	83.38	52.5	54.36	27.5
EaS2T4	04/17/2014	26	28.14	71.62	96.54	72.1	84.01	52	54.48	27.5
EaS2T4	04/17/2014	27	28.22	71.6	97.78	72.2	84.61	51.6	54.42	27.46
EaS2T4	04/17/2014	28	28.18	72.13	98.46	71.9	85.18	51.5	54.44	27.25
EaS2T4	04/17/2014	29	28.18	71.67	99.34	72.2	85.54	51.5	54.4	27.27
EaS2T4	04/17/2014	30	28.2	72.22	100.8	71.6	86.77	52	54.44	27.54

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	Date	Interval	SV3P_C	SV3P_H	HWS	CWS	SV3T_H	CWSP	SV3T_C	HWSP
EaS2T4	04/17/2014	31	28.41	71.55	102	72.1	87.27	52.5	54.44	27.54
EaS2T4	04/17/2014	32	28.62	71.6	103.2	72.2	88.18	52.8	54.38	27.71
EaS2T4	04/17/2014	33	28.45	71.6	103.5	71.5	88.88	53.2	54.38	27.46
EaS2T4	04/17/2014	34	28.51	71.6	104.8	72.1	89.26	52.8	54.46	27.42
EaS2T4	04/17/2014	35	28.2	72.27	105.9	71.5	90.39	52.5	54.42	27.48
EaS2T4	04/17/2014	36	28.22	72.25	106.2	71.6	90.97	52.2	54.46	27.27
EaS2T4	04/17/2014	37	28.2	72.25	106.8	71.6	92.1	52.2	54.36	27.27
EaS2T4	04/17/2014	38	28.22	71.53	108	71.5	92.43	52.3	54.36	27.25
EaS2T4	04/17/2014	39	28.18	71.53	108.6	71.5	93.1	52.5	54.44	27.48
EaS2T4	04/17/2014	40	28.41	72.15	108.9	70.9	93.63	52.7	54.3	27.52
EaS2T4	04/17/2014	41	28.39	72.15	109.4	71.6	94.52	52.9	54.32	27.52
EaS2T4	04/17/2014	42	28.93	72.27	110.1	71	95.14	52.9	54.54	28.27
EaS2T4	04/17/2014	43	35.16	71.62	110.7	71.5	95.65	53.8	54.38	33.98
EaS2T4	04/17/2014	44	35.35	71.62	110.9	71.6	96.58	54.4	54.42	34.42
EaS2T4	04/17/2014	45	35.43	71.53	111.6	70.9	97.26	54.4	54.4	34.35
EaS2T4	04/17/2014	46	35.47	71.55	111.7	71.5	97.86	54.5	54.5	34.4
EaS2T4	04/17/2014	47	35.43	71.55	111.6	71	98.17	54.7	54.36	34.42
EaS2T4	04/17/2014	48	35.43	72.15	112.2	70.9	98.72	54.6	54.4	34.44
EaS2T4	04/17/2014	49	35.58	72.15	112.2	71	99.39	54.4	54.44	34.36
EaS2T4	04/17/2014	50	35.39	71.65	112.1	71	99.9	54.6	54.36	34.42
EaS2T4	04/17/2014	51	35.33	71.55	112.1	71.1	99.87	54.6	54.38	34.4
EaS2T4	04/17/2014	52	35.43	71.6	112.4	71	100.45	54.6	54.3	34.69
EaS2T4	04/17/2014	53	33.46	71.98	112.1	71	100.45	54.1	54.36	32.49
EaS2T4	04/17/2014	54	32.1	71.55	112.5	70.9	101.36	54.1	54.32	30.56
EaS2T4	04/17/2014	55	30.94	72.25	112.8	71	101.48	54	54.34	29.67
EaS2T4	04/17/2014	56	30.83	72.2	112.7	71	101.36	53.4	54.38	29.88
EaS2T4	04/17/2014	57	30.88	71.53	112.8	70.3	102.03	53.4	54.38	30.07
EaS2T4	04/17/2014	58	31.1	72.18	112.7	71	102.01	53.4	54.34	30.13
EaS2T4	04/17/2014	59	30.85	71.58	112.6	70.9	102.49	53.4	54.38	30.11
EaS2T4	04/17/2014	60	30.92	72.27	112.7	70.4	102.56	53.4	54.38	30.11
EaS2T4	04/17/2014	61	30.94	71.58	112.8	70.9	102.66	53.3	54.44	29.82

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	Date	Interval	SV3P_C	SV3P_H	HWS	CWS	SV3T_H	CWSP	SV3T_C	HWSP
EaS2T4	04/17/2014	62	30.85	72.2	112.7	70.4	102.54	53.1	54.28	29.9
EaS2T4	04/17/2014	63	30.88	72.18	112.8	71	103.18	53	54.42	29.9
EaS2T4	04/17/2014	64	30.92	71.53	112.9	70.9	103.21	53	54.36	29.82
EaS2T4	04/17/2014	65	30.86	72.01	112.8	70.4	103.18	53.2	54.4	29.82
EaS2T4	04/17/2014	66	30.86	71.5	112.8	70.9	103.18	53.2	54.34	29.78
EaS2T4	04/17/2014	67	30.85	72.2	112.9	70.3	103.83	53.5	54.42	29.8
EaS2T4	04/17/2014	68	30.83	71.6	112.7	70.9	103.76	53.4	54.38	29.96
EaS2T4	04/17/2014	69	30.81	72.13	112.8	70.9	103.74	53.9	54.44	30.11
EaS2T4	04/17/2014	70	30.98	72.22	113	70.9	103.42	53.8	54.32	30.17
EaS2T4	04/17/2014	71	31.12	71.62	113	70.9	103.76	53.9	54.42	30.13
EaS2T4	04/17/2014	72	30.88	71.65	113.1	70.4	104.31	53.9	54.44	30.19
EaS2T4	04/17/2014	73	30.96	71.55	113.1	70.9	104.43	53.7	54.4	30.09
EaS2T4	04/17/2014	74	30.83	72.22	113.6	71	104.36	53.4	54.34	30.15
EaS2T4	04/17/2014	75	30.9	71.7	113.7	71	104.41	53.7	54.55	30.11
EaS2T4	04/17/2014	76	30.88	72.2	113.6	70.9	104.31	53.7	54.36	30.13
EaS2T4	04/17/2014	77	30.85	72.15	113.6	70.4	104.38	53.7	54.3	30.11
EaS2T4	04/17/2014	78	30.88	71.7	113.7	71	104.67	53.5	54.36	29.86
EaS2T4	04/17/2014	79	30.92	71.53	113.7	70.9	104.72	53.5	54.38	29.86
EaS2T4	04/17/2014	80	30.88	71.6	113.7	70.9	104.7	53.4	54.3	29.88
EaS2T4	04/17/2014	81	30.88	72.13	113.7	71	104.7	53.4	54.44	29.86
EaS2T4	04/17/2014	82	30.94	71.58	113.7	70.3	104.74	53.2	54.28	29.84
EaS2T4	04/17/2014	83	30.85	72.2	113.6	70.9	104.72	53.1	54.4	29.82
EaS2T4	04/17/2014	84	30.83	71.65	113.7	71	104.67	52.9	54.36	29.88
EaS2T4	04/17/2014	85	30.86	71.65	113.6	70.9	105.3	52.9	54.44	29.92
EaS2T4	04/17/2014	86	30.86	71.62	113.6	70.9	105.18	53.2	54.36	29.86
EaS2T4	04/17/2014	87	30.88	71.65	114.3	70.4	105.3	53.5	54.48	29.9
EaS2T4	04/17/2014	88	30.83	71.55	113.6	70.9	105.27	53.4	54.46	29.86
EaS2T4	04/17/2014	89	30.75	71.62	114.2	70.9	105.27	53.4	54.32	29.88
EaS2T4	04/17/2014	90	30.83	72.22	114.3	71	105.3	53.4	54.36	29.9
EaS2T4	04/17/2014	91	30.9	71.55	114.3	70.9	105.37	53.2	54.32	29.86
EaS2T4	04/17/2014	92	30.85	71.58	114.2	70.5	105.3	53.2	54.34	29.84

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	Date	Interval	SV3P_C	SV3P_H	HWS	CWS	SV3T_H	CWSP	SV3T_C	HWSP
EaS2T4	04/17/2014	93	30.88	71.62	114.3	71	105.25	53.2	54.32	29.72
EaS2T4	04/17/2014	94	32.43	71.55	114.1	70.9	105.99	53	54.28	31.54
EaS2T4	04/17/2014	95	33.75	72.13	114.5	70.9	105.61	52.7	54.34	32.76
EaS2T4	04/17/2014	96	34.17	71.67	114.3	71	105.66	52.7	54.4	33.24
EaS2T4	04/17/2014	97	35.14	72.18	114.2	70.9	105.51	53.2	54.36	33.96
EaS2T4	04/17/2014	98	35.12	71.58	114.2	71	105.51	53.2	54.42	34.25
EaS2T4	04/17/2014	99	35.39	71.7	114.3	71	105.87	53.4	54.42	34.46
EaS2T4	04/17/2014	100	35.41	71.62	114.2	71	105.82	53.5	54.36	34.48
EaS2T4	04/17/2014	101	35.43	71.6	114.3	71	105.92	53.4	54.32	34.4
EaS2T4	04/17/2014	102	35.51	72.18	114.3	70.9	105.9	53.4	54.36	34.4
EaS2T4	04/17/2014	103	35.47	71.67	114.9	71	106.02	53.5	54.44	34.4
EaS2T4	04/17/2014	104	35.45	72.13	114.3	70.9	105.85	53.4	54.4	34.46
EaS2T4	04/17/2014	105	35.45	71.62	114.3	70.9	105.87	53.5	54.5	34.44
EaS2T4	04/17/2014	106	35.43	71.62	114.4	70.9	105.9	53.5	54.4	34.38
EaS2T4	04/17/2014	107	35.51	71.6	114.3	70.9	105.94	53.4	54.4	34.42
EaS2T4	04/17/2014	108	35.39	72.01	114.3	70.9	105.94	53.5	54.36	34.38
EaS2T4	04/17/2014	109	35.41	71.62	114.3	70.9	105.9	53.4	54.34	34.5
EaS2T4	04/17/2014	110	35.33	72.25	114.2	70.4	105.87	53.4	54.42	34.46

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Data from Eatherton Method Scenario 1, Test 7

	Date	Interval	SV3P_C	SV3P_H	HWS	CWS	SV3T_H	CWSP	SV3T_C	HWSP
EaS1T7	04/17/2014	1	55.79	70.11	116.8	70.3	71.55	56.3	58.77	55.12
EaS1T7	04/17/2014	2	55.79	69.56	116.8	70.3	71.55	56.3	58.71	55.12
EaS1T7	04/17/2014	3	55.89	70.11	116.9	70.3	71.6	56.3	58.5	55.08
EaS1T7	04/17/2014	4	55.83	69.51	116.9	70.4	71.46	56.1	58.54	55.13
EaS1T7	04/17/2014	5	55.79	70.21	116.9	70.4	71.55	56.3	58.62	55.12
EaS1T7	04/17/2014	6	55.83	70.06	116.9	70.2	71.36	56.4	58.46	55.06
EaS1T7	04/17/2014	7	55.89	70.09	116.9	70.3	71.29	56.1	58.42	55.08
EaS1T7	04/17/2014	8	55.83	69.46	116.9	70.4	71.53	56.1	58.5	55.12
EaS1T7	04/17/2014	9	55.85	70.04	116.9	70.3	71.6	56.1	58.5	55.04
EaS1T7	04/17/2014	10	55.85	69.49	117	70.3	71.6	56.1	58.48	55.1
EaS1T7	04/17/2014	11	55.77	69.39	116.9	70.4	71.29	56.1	58.5	55.15
EaS1T7	04/17/2014	12	55.87	70.11	116.9	70.4	71.36	56.1	58.58	55.12
EaS1T7	04/17/2014	13	55.77	70.16	116.8	70.4	71.53	56.1	58.52	55.12
EaS1T7	04/17/2014	14	24.33	70.18	116.4	70.5	71	55.9	58.31	31.58
EaS1T7	04/17/2014	15	22.47	69.85	116.6	70.3	71.53	54.7	57.15	27.5
EaS1T7	04/17/2014	16	22.47	69.8	116.7	70.4	71.62	54.1	56.28	27.46
EaS1T7	04/17/2014	17	22.47	69.85	116.6	70.4	71.53	53.7	55.7	27.5
EaS1T7	04/17/2014	18	22.18	70.14	116.7	70.4	73.35	53	55.31	27.5
EaS1T7	04/17/2014	19	22.18	70.09	116.6	70	76.3	52.9	55.39	27.5
EaS1T7	04/17/2014	20	22.41	70.14	116.7	70.4	78.99	53.2	55.42	27.48
EaS1T7	04/17/2014	21	22.49	70.11	116.7	70.3	82.81	53.4	55.85	27.4
EaS1T7	04/17/2014	22	22.2	69.8	116.7	70.4	87.44	53.7	55.81	27.46
EaS1T7	04/17/2014	23	22.49	69.75	116.7	70.3	88.57	53.8	56.12	27.4
EaS1T7	04/17/2014	24	22.43	69.8	116.7	70.4	91.26	53.4	55.81	27.42
EaS1T7	04/17/2014	25	22.49	70.09	116.7	70.3	94.06	53.2	55.39	27.44
EaS1T7	04/17/2014	26	22.45	70.02	116.7	70	96.27	53.4	55.89	27.4
EaS1T7	04/17/2014	27	22.45	69.85	116.6	70.4	98.34	54	56.37	27.69
EaS1T7	04/17/2014	28	22.76	69.78	116.7	70.3	100.57	54.4	56.51	27.89
EaS1T7	04/17/2014	29	22.7	69.8	116.7	70.3	102.56	54.4	56.57	27.98
EaS1T7	04/17/2014	30	22.45	69.73	116.7	70.3	104.48	54.2	56.37	27.85

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	Date	Interval	SV3P_C	SV3P_H	HWS	CWS	SV3T_H	CWSP	SV3T_C	HWSP
EaS1T7	04/17/2014	31	22.45	69.82	116.7	70	104.65	53.9	55.87	27.75
EaS1T7	04/17/2014	32	22.41	69.87	116.7	70.4	105.85	53.5	55.54	27.46
EaS1T7	04/17/2014	33	22.47	69.49	116.7	70.3	107.12	53.4	55.5	27.4
EaS1T7	04/17/2014	34	22.53	69.8	116.1	70.3	108.3	53.9	56.24	27.63
EaS1T7	04/17/2014	35	22.22	69.8	116	70.4	109.18	54.4	56.88	27.69
EaS1T7	04/17/2014	36	21.47	69.8	116.3	70.4	110.91	54.5	56.55	26.8
EaS1T7	04/17/2014	37	22.95	69.8	116.3	70.4	110.89	54.4	56.53	28.66
EaS1T7	04/17/2014	38	22.94	69.87	116.1	70.4	111.13	54.2	56.29	28.74
EaS1T7	04/17/2014	39	23.17	69.8	116.1	70.3	111.87	54.2	56.31	28.66
EaS1T7	04/17/2014	40	37.05	69.85	116.6	70.4	112.4	54.8	56.99	35.85
EaS1T7	04/17/2014	41	41.62	69.9	116.6	70.4	112.14	55.4	57.65	40.46
EaS1T7	04/17/2014	42	46.7	69.78	116.3	70.3	112.42	55.4	57.75	44.81
EaS1T7	04/17/2014	43	50.01	70.14	116.1	70.4	110.6	55.6	58.04	49.55
EaS1T7	04/17/2014	44	52.68	69.61	116.3	70.4	109.14	55.8	58.27	52.04
EaS1T7	04/17/2014	45	54.67	69.46	116.1	70.4	108.01	55.8	58.29	53.86
EaS1T7	04/17/2014	46	55.13	69.44	115.7	70.5	106.16	55.9	58.25	54.42
EaS1T7	04/17/2014	47	55.33	69.58	115.7	70.4	104.7	55.9	58.33	54.61
EaS1T7	04/17/2014	48	55.35	69.54	115.7	70.4	102.85	55.9	58.29	54.67
EaS1T7	04/17/2014	49	55.39	69.58	115.8	70.4	101.7	55.6	58.05	54.55
EaS1T7	04/17/2014	50	55.35	70.06	115.7	70.3	100.78	55.8	58.27	54.65
EaS1T7	04/17/2014	51	55.42	69.46	115.7	70.3	99.68	55.5	58.25	54.63
EaS1T7	04/17/2014	52	55.12	69.82	115.7	70.4	98.94	54.4	57.07	54.44
EaS1T7	04/17/2014	53	41.64	69.87	115.2	70.4	97.83	54.4	56.89	40.22
EaS1T7	04/17/2014	54	30.17	69.22	116	70.4	98.07	54	56.41	28.25
EaS1T7	04/17/2014	55	30.32	69.82	116.6	70.3	97.54	53.7	55.99	28.78
EaS1T7	04/17/2014	56	34	69.75	116	70.3	97.26	53.5	55.85	32.51
EaS1T7	04/17/2014	57	34.25	69.75	116.7	70.4	96.06	53.6	56.04	32.53
EaS1T7	04/17/2014	58	33.9	69.8	116.6	70	94.5	53.9	56.43	32.31
EaS1T7	04/17/2014	59	33.69	69.85	116.6	70.4	93.37	53.9	56.41	32.08
EaS1T7	04/17/2014	60	33.51	69.8	116.7	70.3	92.55	53.7	55.93	31.77
EaS1T7	04/17/2014	61	33.32	69.75	116.7	70	90.78	53.2	55.56	31.5

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	Date	Interval	SV3P_C	SV3P_H	HWS	CWS	SV3T_H	CWSP	SV3T_C	HWSP
EaS1T7	04/17/2014	62	33.26	70.21	116.6	70.4	89.82	53.2	55.25	31.31
EaS1T7	04/17/2014	63	33.28	70.09	116.7	70	88.3	53.2	55.23	31.31
EaS1T7	04/17/2014	64	33.3	70.11	116.7	70	87.73	52.9	55.27	31.27
EaS1T7	04/17/2014	65	33.22	69.56	117.2	70.1	86.46	52.7	55.39	31.29
EaS1T7	04/17/2014	66	33.28	70.11	117.3	70	85.59	52.7	55.23	31.27
EaS1T7	04/17/2014	67	33.3	70.09	117.2	70.6	84.97	52.7	55.08	31.23
EaS1T7	04/17/2014	68	33.01	69.99	117.2	70	83.79	52.7	55.08	31.29
EaS1T7	04/17/2014	69	33.01	70.06	117.2	70.1	82.9	52.8	55.23	31.33
EaS1T7	04/17/2014	70	33.34	70.14	117.3	70.7	82.33	52.4	55.15	31.29
EaS1T7	04/17/2014	71	33.03	70.06	117.3	70.1	81.42	52.5	55.1	31.35
EaS1T7	04/17/2014	72	33.01	69.44	117.2	70.1	80.89	52.4	54.75	31.23
EaS1T7	04/17/2014	73	33.07	70.11	117.3	70.1	80.26	52.5	54.71	31.25
EaS1T7	04/17/2014	74	32.99	70.04	117.2	70	79.93	52.5	55.08	31.33
EaS1T7	04/17/2014	75	33.05	70.04	117.3	70.7	79.4	52.4	54.83	31.31
EaS1T7	04/17/2014	76	33.07	70.11	116.7	70	79.42	52.5	54.9	31.29
EaS1T7	04/17/2014	77	33.28	70.09	116.6	70	78.66	52.2	54.55	31.35
EaS1T7	04/17/2014	78	33.01	70.09	116.4	70.6	78.2	52.2	54.57	31.25
EaS1T7	04/17/2014	79	33.07	69.44	115.8	70	77.91	52.2	54.61	31.29
EaS1T7	04/17/2014	80	33.01	70.04	115.8	70.6	77.74	52	54.54	31.33
EaS1T7	04/17/2014	81	33.01	70.16	114.5	70.1	77.19	52	54.67	31.35
EaS1T7	04/17/2014	82	32.93	70.09	113.9	70.1	77.14	51.9	54.54	31.35
EaS1T7	04/17/2014	83	32.95	70.18	113.6	70	76.64	52.1	54.63	31.35
EaS1T7	04/17/2014	84	33.03	70.11	113.1	70	76.5	52.2	54.57	31.25
EaS1T7	04/17/2014	85	33.07	70.14	112.5	70.7	76.09	52	54.57	31.23
EaS1T7	04/17/2014	86	32.95	69.49	111.3	70	75.78	52	54.63	31.1
EaS1T7	04/17/2014	87	33.01	70.11	110.7	70	75.78	51.9	54.48	31.27
EaS1T7	04/17/2014	88	33.07	69.49	110.1	70.6	75.82	52	54.46	31.21
EaS1T7	04/17/2014	89	32.78	70.09	109.8	70	75.13	51.7	54.09	31.06
EaS1T7	04/17/2014	90	32.78	70.09	109.2	70	75.1	51.5	53.92	31
EaS1T7	04/17/2014	91	32.88	70.11	108.7	70	74.89	51.3	53.43	31
EaS1T7	04/17/2014	92	32.74	70.45	107.7	70.1	74.89	51.1	53.41	31.1

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	Date	Interval	SV3P_C	SV3P_H	HWS	CWS	SV3T_H	CWSP	SV3T_C	HWSP
EaS1T7	04/17/2014	93	32.76	69.46	107.1	70.6	75.2	51	53.37	31.02
EaS1T7	04/17/2014	94	32.76	70.14	106.5	70	74.86	51.3	53.7	31.06
EaS1T7	04/17/2014	95	32.76	69.61	105.9	70.1	74.26	51.3	53.66	31.1
EaS1T7	04/17/2014	96	32.78	70.04	105.3	70	74.89	51.3	53.7	31.02
EaS1T7	04/17/2014	97	32.76	70.14	104.7	70	74.79	51.3	53.88	31.12
EaS1T7	04/17/2014	98	32.72	70.14	104.4	70.4	74.26	51.6	53.9	31.06
EaS1T7	04/17/2014	99	34.5	69.54	103.8	70	74	52	53.92	32.68
EaS1T7	04/17/2014	100	39.06	70.06	103.7	70.1	74.22	52	54.38	38.54
EaS1T7	04/17/2014	101	44.09	70.18	103.1	70.6	74.26	52	54.71	42.66
EaS1T7	04/17/2014	102	46.97	70.11	102.3	70.1	74.14	52.6	55.12	46.66
EaS1T7	04/17/2014	103	50.22	70.09	101.9	70	73.4	52.9	55.31	49.29
EaS1T7	04/17/2014	104	51.77	70.16	101.7	70.4	73.64	53.2	55.33	50.76
EaS1T7	04/17/2014	105	52.7	70.14	101.4	70.1	73.66	53.3	55.5	51.79
EaS1T7	04/17/2014	106	52.74	70.11	100.8	70.3	73.64	53.2	55.56	52.02
EaS1T7	04/17/2014	107	52.93	70.14	100.1	70.5	73.62	53.2	55.62	52.02
EaS1T7	04/17/2014	108	52.93	70.11	100.2	70.4	73.02	53.2	55.31	52
EaS1T7	04/17/2014	109	52.68	70.09	99.58	70.4	73.06	53.2	55.23	51.98
EaS1T7	04/17/2014	110	52.7	70.11	99.56	70.4	73.62	53.2	55.42	51.98
EaS1T7	04/17/2014	111	52.95	70.09	99.27	70.3	73.74	53.2	55.27	51.96

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Data from the Circ through Cold Test

	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	1	85.78	71.79	52.93	52.7	68.02	69.46	6.11	5.67
CircthruCW	02/20/2014	2	85.88	71.74	52.95	52.72	67.98	68.86	6.11	5.61
CircthruCW	02/20/2014	3	85.86	71.67	52.95	52.72	67.9	68.86	5.82	5.63
CircthruCW	02/20/2014	4	85.83	71.74	52.76	52.7	68	69.51	5.88	5.7
CircthruCW	02/20/2014	5	85.83	71.86	52.89	52.76	68.07	68.91	5.88	5.67
CircthruCW	02/20/2014	6	85.81	71.82	52.87	52.76	68.05	68.84	5.88	5.7
CircthruCW	02/20/2014	7	85.74	71.84	52.89	52.72	68.65	69.34	5.94	5.69
CircthruCW	02/20/2014	8	85.88	71.89	52.91	52.72	68.05	68.91	5.92	5.65
CircthruCW	02/20/2014	9	85.9	71.79	52.91	52.68	68.62	69.42	5.82	5.7
CircthruCW	02/20/2014	10	86.53	71.82	52.95	52.68	68.02	69.42	5.86	5.49
CircthruCW	02/20/2014	11	85.9	71.77	52.95	52.7	68.43	69.44	5.92	5.4
CircthruCW	02/20/2014	12	85.9	71.79	52.93	52.7	68.62	69.44	5.84	5.45
CircthruCW	02/20/2014	13	85.81	71.91	52.89	52.7	68.62	69.27	5.69	5.4
CircthruCW	02/20/2014	14	85.86	71.77	47.13	52.76	68.07	69.51	5.65	5.38
CircthruCW	02/20/2014	15	86.12	71.82	47.13	52.7	68.05	69.44	5.74	5.41
CircthruCW	02/20/2014	16	86.12	71.77	46.92	52.7	68.02	69.39	5.69	5.38
CircthruCW	02/20/2014	17	86.12	71.96	47.36	52.72	68.1	69.49	5.69	5.4
CircthruCW	02/20/2014	18	86.22	71.77	46.92	52.74	68.6	69.42	5.82	5.43
CircthruCW	02/20/2014	19	86.38	71.79	46.93	52.72	68.67	68.89	5.69	5.34
CircthruCW	02/20/2014	20	87.08	71.74	47.46	52.76	68.55	69.49	5.7	5.43
CircthruCW	02/20/2014	21	88.54	71.79	46.99	52.66	68.62	69.44	5.61	5.43
CircthruCW	02/20/2014	22	91.26	71.7	46.93	52.74	68	68.89	5.61	5.45
CircthruCW	02/20/2014	23	94.04	71.72	47.05	52.72	67.95	68.91	5.65	5.41
CircthruCW	02/20/2014	24	96.01	71.22	46.43	52.78	68.07	69.27	5.65	5.43
CircthruCW	02/20/2014	25	99.66	71.72	46.47	52.72	68.65	68.86	5.67	5.41
CircthruCW	02/20/2014	26	101.7	71.74	46.53	52.74	68.62	69.46	5.67	5.4
CircthruCW	02/20/2014	27	104.46	71.74	46.68	52.7	67.95	69.46	5.63	5.2
CircthruCW	02/20/2014	28	106.4	71.82	46.68	52.72	68.58	69.44	5.9	5.43
CircthruCW	02/20/2014	29	109.16	71.72	46.74	52.52	67.98	69.49	5.9	5.45
CircthruCW	02/20/2014	30	110.91	71.74	46.66	52.47	67.98	69.2	5.86	5.67

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	31	111.85	71.17	46.7	52.47	67.95	69.42	5.88	5.43
CircthruCW	02/20/2014	32	113.55	71.86	46.68	52.47	68.67	69.49	5.67	5.38
CircthruCW	02/20/2014	33	115.16	71.77	46.66	52.41	68.65	68.84	6.03	5.65
CircthruCW	02/20/2014	34	116.82	71.82	46.45	52.49	68	68.86	5.92	5.59
CircthruCW	02/20/2014	35	117.51	71.77	46.47	52.5	67.93	69.49	5.98	5.69
CircthruCW	02/20/2014	36	118.71	71.72	46.72	52.41	67.98	69.49	5.88	5.61
CircthruCW	02/20/2014	37	118.98	71.84	46.47	52.45	67.98	69.49	5.88	5.67
CircthruCW	02/20/2014	38	120.1	71.77	46.51	52.47	67.95	69.49	5.86	5.69
CircthruCW	02/20/2014	39	120.78	71.79	46.2	52.5	68.55	69.49	5.88	5.67
CircthruCW	02/20/2014	40	121.35	71.89	45.95	52.47	68.62	69.46	5.86	5.34
CircthruCW	02/20/2014	41	121.93	71.79	46.66	52.47	68.07	69.22	5.94	5.4
CircthruCW	02/20/2014	42	121.71	71.79	46.64	52.5	68.02	68.94	5.88	5.4
CircthruCW	02/20/2014	43	122.34	71.77	46.7	52.2	68	69.42	5.59	5.43
CircthruCW	02/20/2014	44	122.86	71.74	46.51	52.21	68.58	69.44	5.61	5.43
CircthruCW	02/20/2014	45	122.82	71.72	46.2	52.18	68	69.42	5.59	5.47
CircthruCW	02/20/2014	46	123.46	71.79	46.24	52.2	68.58	69.37	5.65	5.41
CircthruCW	02/20/2014	47	123.44	71.5	46.26	52.23	68.41	69.44	5.82	5.41
CircthruCW	02/20/2014	48	124.02	71.19	46.22	52.18	67.93	69.42	5.86	5.4
CircthruCW	02/20/2014	49	124.09	71.82	46.24	52.2	67.98	71.26	13.34	5.43
CircthruCW	02/20/2014	50	124.04	71.7	46.28	51.98	67.95	69.13	49.58	47.44
CircthruCW	02/20/2014	51	124.04	71.19	46.72	51.94	68.26	68.86	55.29	47.96
CircthruCW	02/20/2014	52	124.59	71.22	46.45	52	68.36	68.86	55.33	47.84
CircthruCW	02/20/2014	53	124.62	71.82	46.41	52	68.1	68.91	55.37	47.88
CircthruCW	02/20/2014	54	124.62	71.74	46.41	52.04	68.07	68.91	55.37	47.9
CircthruCW	02/20/2014	55	124.66	71.62	46.45	51.94	68.05	68.84	55.35	47.94
CircthruCW	02/20/2014	56	124.06	71.72	46.47	51.94	67.95	68.89	55.33	47.9
CircthruCW	02/20/2014	57	123.97	71.79	46.43	52.02	68.05	68.89	55.33	47.92
CircthruCW	02/20/2014	58	123.97	71.19	46.45	52	68.41	69.1	55.37	47.86
CircthruCW	02/20/2014	59	123.42	71.77	46.45	51.94	68.29	69.18	55.37	47.88
CircthruCW	02/20/2014	60	123.46	71.72	46.45	51.94	68	69.44	55.35	47.69
CircthruCW	02/20/2014	61	123.51	71.48	46.2	51.96	67.98	69.18	55.41	47.67

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	62	123.46	71.41	46.49	51.96	68	69.15	55.29	47.65
CircthruCW	02/20/2014	63	122.84	71.72	46.45	51.92	68.26	69.08	55.31	47.65
CircthruCW	02/20/2014	64	122.89	71.79	46.47	51.94	68.34	69.15	55.39	47.71
CircthruCW	02/20/2014	65	122.86	71.77	46.49	51.96	68	69.46	55.35	47.69
CircthruCW	02/20/2014	66	122.79	71.79	46.22	52	68.02	69.51	55.37	47.69
CircthruCW	02/20/2014	67	122.79	71.89	46.14	52	68.36	69.18	55.42	47.65
CircthruCW	02/20/2014	68	122.17	71.79	46.2	51.79	68.38	69.22	55.44	47.61
CircthruCW	02/20/2014	69	122.24	71.79	46.22	52.02	68.34	69.51	55.46	47.67
CircthruCW	02/20/2014	70	122.29	71.72	46.24	51.73	68.29	69.42	55.29	47.69
CircthruCW	02/20/2014	71	122.29	71.7	46.28	51.75	68.26	69.46	55.15	47.4
CircthruCW	02/20/2014	72	122.24	71.48	46.2	51.79	68.29	69.51	55.1	47.42
CircthruCW	02/20/2014	73	122.36	71.46	46.24	51.71	68.29	69.51	55.12	47.46
CircthruCW	02/20/2014	74	122.22	71.74	46.32	51.77	68.24	70.06	55.06	47.44
CircthruCW	02/20/2014	75	122.24	71.77	46.22	51.77	68.31	69.78	55.15	47.46
CircthruCW	02/20/2014	76	121.9	71.55	46.18	51.79	68.34	69.49	55.12	47.4
CircthruCW	02/20/2014	77	121.95	71.79	46.18	51.77	68.96	69.44	55.19	47.36
CircthruCW	02/20/2014	78	121.9	71.77	46.22	51.54	68.36	70.11	55.15	47.38
CircthruCW	02/20/2014	79	121.98	71.5	46.01	51.52	68.94	70.06	55.15	47.46
CircthruCW	02/20/2014	80	122.24	71.77	45.97	51.52	68.31	70.09	55.15	47.36
CircthruCW	02/20/2014	81	121.93	71.72	45.99	51.5	68.36	70.02	55.1	47.4
CircthruCW	02/20/2014	82	121.88	71.55	45.97	51.52	68.96	70.71	55.15	47.36
CircthruCW	02/20/2014	83	121.98	71.74	46.03	51.5	68.86	70.62	55.15	47.38
CircthruCW	02/20/2014	84	121.93	71.86	45.93	51.54	68.96	70.14	55.19	47.42
CircthruCW	02/20/2014	85	122.29	71.79	45.99	51.54	68.96	70.06	55.17	47.34
CircthruCW	02/20/2014	86	121.93	71.5	45.93	51.5	69.06	70.74	55.15	47.36
CircthruCW	02/20/2014	87	122.05	71.77	45.99	51.46	68.89	70.69	55.1	47.42
CircthruCW	02/20/2014	88	121.95	71.82	45.99	51.5	68.94	70.66	54.92	47.19
CircthruCW	02/20/2014	89	121.88	71.79	45.95	51.54	68.98	70.69	54.94	47.17
CircthruCW	02/20/2014	90	121.95	71.84	45.97	51.54	68.96	70.66	54.94	47.17
CircthruCW	02/20/2014	91	121.93	71.79	45.95	51.5	69.54	71	54.94	47.11
CircthruCW	02/20/2014	92	121.88	71.89	45.97	51.56	68.94	70.66	54.92	47.11

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	93	121.93	71.74	45.97	51.56	68.96	70.69	54.92	47.17
CircthruCW	02/20/2014	94	121.88	72.46	45.99	51.5	68.98	71.02	54.94	47.11
CircthruCW	02/20/2014	95	122	71.77	50.57	51.32	69.03	71.29	54.67	51.69
CircthruCW	02/20/2014	96	121.59	71.82	51.03	51.29	69.49	70.64	54.73	52
CircthruCW	02/20/2014	97	121.9	71.79	49.86	50.76	69.56	70.66	54.46	51.75
CircthruCW	02/20/2014	98	121.62	72.63	46.76	50.55	69.46	70.95	53.9	48.19
CircthruCW	02/20/2014	99	121.64	72.1	48.89	50.28	69.13	71.29	53.41	50.15
CircthruCW	02/20/2014	100	121.59	72.49	48.87	50.01	69.2	71.22	53.45	50.36
CircthruCW	02/20/2014	101	121.62	72.66	48.93	49.58	69.13	70.62	53.18	50.13
CircthruCW	02/20/2014	102	121.62	72.13	48.62	49.55	69.73	70.64	53.1	50.03
CircthruCW	02/20/2014	103	121.57	72.08	43.59	50.05	69.8	71.29	53.34	45.5
CircthruCW	02/20/2014	104	121.95	72.61	45.12	50.07	69.44	71.26	53.39	46.2
CircthruCW	02/20/2014	105	121.93	72.68	44.48	50.03	69.46	71.22	53.45	46.05
CircthruCW	02/20/2014	106	121.98	72.68	44.52	50.03	69.49	71.17	53.49	46.03
CircthruCW	02/20/2014	107	121.95	72.78	44.75	50.55	69.54	71.29	53.9	46.16
CircthruCW	02/20/2014	108	121.98	73.18	44.75	50.34	69.42	71.29	53.61	46.2
CircthruCW	02/20/2014	109	122	72.73	44.75	50.28	70.11	71.31	53.63	46.24
CircthruCW	02/20/2014	110	121.95	72.66	44.81	50.53	70.06	71.24	53.88	46.24
CircthruCW	02/20/2014	111	121.93	73.06	44.71	50.57	69.46	71.89	53.97	46.2
CircthruCW	02/20/2014	112	121.98	73.02	44.75	50.53	70.14	71.89	53.88	46.2
CircthruCW	02/20/2014	113	121.9	72.8	45	50.57	69.54	71.31	53.94	46.2
CircthruCW	02/20/2014	114	121.88	73.02	44.98	50.57	70.09	71.89	53.94	46.18
CircthruCW	02/20/2014	115	121.98	72.99	44.98	50.53	70.09	71.79	53.84	46.26
CircthruCW	02/20/2014	116	121.93	72.68	44.85	50.53	70.02	71.84	53.84	46.24
CircthruCW	02/20/2014	117	122	72.56	45	50.51	70.04	71.82	53.88	46.26
CircthruCW	02/20/2014	118	121.9	73.04	45.04	50.53	70.09	71.82	53.84	46.26
CircthruCW	02/20/2014	119	121.9	72.73	44.96	50.61	70.14	71.89	53.92	46.18
CircthruCW	02/20/2014	120	121.88	72.75	44.96	50.53	70.09	72.08	53.92	46.22
CircthruCW	02/20/2014	121	121.95	73.02	45.06	50.51	70.69	72.1	53.94	46.22
CircthruCW	02/20/2014	122	121.86	73.02	45	50.61	70.11	72.22	53.99	46.2
CircthruCW	02/20/2014	123	122	72.66	45.02	50.61	70.69	71.89	53.9	46.2

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	124	121.83	73.04	44.79	50.55	70.71	72.18	53.97	46.18
CircthruCW	02/20/2014	125	121.93	72.94	44.85	50.59	70.02	72.1	53.9	46.24
CircthruCW	02/20/2014	126	121.93	72.97	44.79	50.22	70.14	72.15	53.66	46.22
CircthruCW	02/20/2014	127	121.98	73.26	44.79	50.32	70.11	72.13	53.7	46.01
CircthruCW	02/20/2014	128	121.95	73.35	44.73	50.32	70.69	72.15	53.45	46.14
CircthruCW	02/20/2014	129	121.93	73.28	44.73	50.13	70.71	72.2	53.65	45.93
CircthruCW	02/20/2014	130	121.38	73.28	44.5	50.11	70.69	72.75	53.49	45.93
CircthruCW	02/20/2014	131	121.86	73.18	44.71	49.99	70.71	72.68	53.34	45.91
CircthruCW	02/20/2014	132	121.62	73.23	44.52	50.05	70.64	72.39	53.39	46.03
CircthruCW	02/20/2014	133	121.42	72.75	44.48	50.05	70.69	72.73	53.41	46.05
CircthruCW	02/20/2014	134	121.35	73.4	44.25	49.89	70.71	72.8	53.43	45.97
CircthruCW	02/20/2014	135	121.38	73.3	43.98	49.57	70.69	72.8	53.01	45.48
CircthruCW	02/20/2014	136	121.42	73.28	43.82	49.31	70.71	72.75	52.68	45.39
CircthruCW	02/20/2014	137	121.35	72.75	43.84	49.31	70.64	72.73	52.72	45.48
CircthruCW	02/20/2014	138	121.38	73.38	43.78	49.35	70.66	73.47	52.79	45.31
CircthruCW	02/20/2014	139	121.64	73.33	43.59	49.12	71.34	73.35	52.76	45.02
CircthruCW	02/20/2014	140	121.62	72.7	43.55	49.12	70.69	72.78	52.72	45
CircthruCW	02/20/2014	141	121.66	73.35	43.55	49.35	70.69	72.75	52.47	45.04
CircthruCW	02/20/2014	142	121.62	73.33	43.55	49.02	71.24	73.33	52.47	45.08
CircthruCW	02/20/2014	143	121.14	72.66	43.61	49.08	70.62	73.35	52.49	45.04
CircthruCW	02/20/2014	144	121.64	73.3	43.3	49.06	71.22	73.4	52.43	45.04
CircthruCW	02/20/2014	145	121.04	73.38	43.28	48.85	71.29	72.73	52.25	45
CircthruCW	02/20/2014	146	121.06	73.28	43.11	48.87	71.24	72.75	52.25	44.81
CircthruCW	02/20/2014	147	121.62	72.68	43.53	49.57	71.24	73.28	52.89	45.02
CircthruCW	02/20/2014	148	121.33	73.28	44.3	50.01	71.31	73.3	53.37	45.74
CircthruCW	02/20/2014	149	121.35	73.54	44.85	50.55	71.24	73.35	53.86	46.2
CircthruCW	02/20/2014	150	121.38	72.92	45	50.53	71.67	73.3	53.86	46.26
CircthruCW	02/20/2014	151	121.38	73.52	45.06	50.51	71.84	73.28	53.84	46.49
CircthruCW	02/20/2014	152	121.33	73.59	45.1	50.53	71.86	73.71	53.86	46.45
CircthruCW	02/20/2014	153	121.33	73.23	45.02	50.51	71.91	73.59	53.88	46.45
CircthruCW	02/20/2014	154	121.35	73.66	45.23	50.8	71.34	73.4	54.48	46.68

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	155	121.3	73.64	45.48	51.05	71.62	73.66	54.73	46.93
CircthruCW	02/20/2014	156	121.3	73.64	45.45	51.03	71.6	73.71	54.46	46.97
CircthruCW	02/20/2014	157	121.3	73.64	45.47	50.78	71.6	73.69	54.48	46.64
CircthruCW	02/20/2014	158	121.4	73.66	45.47	50.82	71.65	73.69	54.5	46.68
CircthruCW	02/20/2014	159	121.4	73.64	45.47	50.8	71.6	73.71	54.54	46.68
CircthruCW	02/20/2014	160	120.73	73.64	45.54	50.74	72.2	73.62	54.38	46.74
CircthruCW	02/20/2014	161	121.38	73.57	45.25	50.76	71.53	73.66	54.42	46.68
CircthruCW	02/20/2014	162	121.38	74.24	45.45	51.02	71.62	73.71	54.44	46.97
CircthruCW	02/20/2014	163	121.35	73.64	45.45	51.23	71.58	73.66	54.61	46.92
CircthruCW	02/20/2014	164	121.35	73.57	45.52	51.23	72.18	73.64	54.69	46.99
CircthruCW	02/20/2014	165	121.35	73.57	45.48	51.21	72.13	73.59	54.65	46.99
CircthruCW	02/20/2014	166	120.82	74.24	45.23	50.82	72.22	73.64	54.44	46.66
CircthruCW	02/20/2014	167	121.38	73.64	45.23	50.8	72.2	73.66	54.5	46.64
CircthruCW	02/20/2014	168	120.78	74.24	45.23	51.05	71.62	73.64	54.5	46.7
CircthruCW	02/20/2014	169	120.68	74.17	45.48	51.02	72.18	74.24	54.65	46.99
CircthruCW	02/20/2014	170	120.75	74.19	45.29	51.03	72.15	74.19	54.69	46.84
CircthruCW	02/20/2014	171	121.4	74.12	45.48	51	72.1	74.22	54.46	46.7
CircthruCW	02/20/2014	172	120.66	74.1	45.48	50.98	72.2	73.62	54.65	46.92
CircthruCW	02/20/2014	173	120.94	73.88	45.45	51.03	72.22	74.26	54.73	46.9
CircthruCW	02/20/2014	174	120.82	74.22	45.5	51.07	72.13	74.26	54.69	46.97
CircthruCW	02/20/2014	175	120.78	74.26	45.48	51.03	72.22	74.26	54.73	46.9
CircthruCW	02/20/2014	176	120.82	74.26	45.12	50.07	72.2	73.71	53.97	46.68
CircthruCW	02/20/2014	177	121.06	73.98	43.3	48.89	72.54	74.24	51.98	45.21
CircthruCW	02/20/2014	178	120.46	74.19	42.6	48.1	72.54	74.53	51.54	44.27
CircthruCW	02/20/2014	179	121.09	74.17	43.14	49.1	72.49	74.53	52.49	44.77
CircthruCW	02/20/2014	180	121.06	74.19	44.01	49.82	72.15	74.19	53.18	45.54
CircthruCW	02/20/2014	181	120.99	74.22	44.79	50.32	72.18	74.29	53.94	46.16
CircthruCW	02/20/2014	182	120.75	74.84	45.16	51.03	72.8	74.36	54.48	46.66
CircthruCW	02/20/2014	183	120.78	74.86	45.48	51.03	72.25	74.89	54.5	46.66
CircthruCW	02/20/2014	184	120.75	74.22	45.06	50.78	72.18	74.14	54.17	46.74
CircthruCW	02/20/2014	185	120.73	74.79	45.5	51.29	72.78	74.29	54.42	46.78

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	186	120.85	74.58	45.72	51.29	72.8	74.91	54.94	47.13
CircthruCW	02/20/2014	187	120.73	74.53	45.52	51.29	72.78	74.86	54.75	46.93
CircthruCW	02/20/2014	188	120.78	74.77	45.58	51.27	72.75	74.89	54.65	46.97
CircthruCW	02/20/2014	189	120.7	75.13	45.91	51.52	72.8	74.91	55.15	47.19
CircthruCW	02/20/2014	190	120.87	74.53	45.99	51.44	72.42	74.79	55.17	47.46
CircthruCW	02/20/2014	191	120.73	74.5	46.05	51.25	72.75	74.77	54.84	47.17
CircthruCW	02/20/2014	192	120.68	75.01	45.97	51.5	73.04	75.08	55.12	47.42
CircthruCW	02/20/2014	193	120.75	74.53	46.18	51.71	73.16	74.79	55.39	47.69
CircthruCW	02/20/2014	194	120.75	74.5	46.16	51.77	73.09	75.13	55.12	47.61
CircthruCW	02/20/2014	195	120.73	75.06	46.18	51.79	73.11	75.18	55.21	47.42
CircthruCW	02/20/2014	196	120.73	75.13	46.22	52	73.11	75.18	55.44	47.59
CircthruCW	02/20/2014	197	120.78	74.5	46.16	51.5	73.11	75.15	55.17	47.44
CircthruCW	02/20/2014	198	120.8	75.06	45.99	51.48	72.97	75.1	55.12	47.42
CircthruCW	02/20/2014	199	120.73	75.13	46.26	51.54	73.11	74.96	55.06	47.44
CircthruCW	02/20/2014	200	120.75	74.43	46.26	51.71	73.09	75.15	55.12	47.46
CircthruCW	02/20/2014	201	120.7	75.03	46.22	51.73	73.04	75.1	55.1	47.38
CircthruCW	02/20/2014	202	120.68	75.08	46.47	51.94	73.09	75.08	55.37	47.98
CircthruCW	02/20/2014	203	120.68	75.03	46.76	52.21	73.69	75.08	55.62	48.13
CircthruCW	02/20/2014	204	120.78	75.08	46.74	52.43	73.04	75.13	55.35	48.17
CircthruCW	02/20/2014	205	120.73	75.06	46.7	52.43	73.71	75.73	55.6	48.17
CircthruCW	02/20/2014	206	120.75	75.08	47.01	52.45	73.69	75.15	55.83	48.1
CircthruCW	02/20/2014	207	120.73	75.08	46.9	52.41	73.69	75.1	55.87	48.37
CircthruCW	02/20/2014	208	120.8	75.1	46.95	52.41	73.74	75.7	55.87	48.19
CircthruCW	02/20/2014	209	120.75	75.03	47.03	52.47	73.69	75.8	55.77	48.42
CircthruCW	02/20/2014	210	120.73	75.13	46.88	52.52	73.76	75.75	55.87	48.4
CircthruCW	02/20/2014	211	120.78	75.06	46.92	52.45	73.76	75.8	55.79	48.37
CircthruCW	02/20/2014	212	120.78	75.42	46.92	52.5	73.78	75.75	55.85	48.35
CircthruCW	02/20/2014	213	120.8	75.32	46.93	52.47	73.66	75.73	55.77	48.4
CircthruCW	02/20/2014	214	120.13	75.37	46.95	52.47	73.95	75.73	55.75	48.42
CircthruCW	02/20/2014	215	120.7	75.37	46.97	52.45	74	75.75	55.83	48.39
CircthruCW	02/20/2014	216	120.78	76.02	47.01	52.41	73.95	75.82	55.81	48.11

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	217	120.7	75.97	46.95	52.47	73.71	76.02	55.7	48.46
CircthruCW	02/20/2014	218	120.75	75.99	46.99	52.45	73.71	76.09	55.81	48.13
CircthruCW	02/20/2014	219	120.68	76.59	46.93	52.49	73.9	76.06	55.77	48.13
CircthruCW	02/20/2014	220	120.18	75.99	46.95	52.49	73.76	76.06	55.75	48.35
CircthruCW	02/20/2014	221	120.1	76.64	46.92	52.5	74.02	75.78	55.79	48.13
CircthruCW	02/20/2014	222	120.78	76.54	46.97	52.45	73.95	76.04	55.73	48.15
CircthruCW	02/20/2014	223	120.68	76.59	46.99	52.45	73.95	76.04	55.75	48.21
CircthruCW	02/20/2014	224	120.18	76.88	47.01	52.5	73.93	76.14	55.77	48.21
CircthruCW	02/20/2014	225	120.18	76.86	46.7	52.45	73.9	76.06	55.54	48.17
CircthruCW	02/20/2014	226	120.68	76.83	46.7	52.45	73.95	75.97	55.56	48.13
CircthruCW	02/20/2014	227	120.78	76.95	46.74	52.49	73.88	75.99	55.54	48.1
CircthruCW	02/20/2014	228	120.78	77.5	46.68	52.49	73.98	76.06	55.66	48.11
CircthruCW	02/20/2014	229	120.1	78.06	46.7	52.5	74	75.99	55.62	48.11
CircthruCW	02/20/2014	230	120.13	78.08	46.74	52.45	74.55	76.09	55.58	48.1
CircthruCW	02/20/2014	231	120.08	78.58	46.7	52.47	73.98	75.97	55.81	48.17
CircthruCW	02/20/2014	232	120.22	78.58	46.68	52.5	74.55	76.11	55.79	48.21
CircthruCW	02/20/2014	233	120.15	78.63	46.68	52.47	74	76.06	55.85	48.11
CircthruCW	02/20/2014	234	120.25	79.23	46.68	52.43	73.9	76.04	55.46	48.17
CircthruCW	02/20/2014	235	120.15	79.23	46.72	52.45	74.48	76.54	55.62	48.17
CircthruCW	02/20/2014	236	120.18	79.21	46.74	52.45	74.53	76.64	55.68	48.21
CircthruCW	02/20/2014	237	120.13	79.21	46.72	52.45	74.5	76.04	55.73	48.19
CircthruCW	02/20/2014	238	120.13	79.54	46.95	52.41	74.55	76.02	55.7	48.15
CircthruCW	02/20/2014	239	120.25	79.62	46.84	52.49	74.6	76.74	55.83	48.17
CircthruCW	02/20/2014	240	120.2	79.59	46.92	52.52	74.6	76.64	55.83	48.17
CircthruCW	02/20/2014	241	120.1	80.12	46.97	52.47	74.55	76.57	55.79	48.19
CircthruCW	02/20/2014	242	120.18	80.17	46.86	52.47	74.62	76.14	55.87	48.11
CircthruCW	02/20/2014	243	120.13	80.14	47.01	52.47	75.06	76.02	55.75	48.19
CircthruCW	02/20/2014	244	120.22	80.74	46.93	52.49	75.13	76.66	55.85	48.21
CircthruCW	02/20/2014	245	120.15	80.79	46.93	52.49	74.53	76.69	55.83	48.33
CircthruCW	02/20/2014	246	120.18	80.79	46.93	52.5	75.22	76.74	55.81	48.35
CircthruCW	02/20/2014	247	120.2	80.79	46.97	52.74	74.46	76.71	55.85	48.4

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	248	120.2	81.03	46.92	52.72	75.15	77.29	55.81	48.35
CircthruCW	02/20/2014	249	120.18	81.08	46.92	52.74	75.15	77.24	55.83	48.37
CircthruCW	02/20/2014	250	120.22	81.03	46.99	52.76	75.13	76.98	55.75	48.44
CircthruCW	02/20/2014	251	120.15	81.63	46.95	52.74	75.46	76.52	55.83	48.66
CircthruCW	02/20/2014	252	120.2	81.63	46.95	52.7	75.1	77.17	55.97	48.69
CircthruCW	02/20/2014	253	120.2	81.63	46.95	52.66	75.3	77.74	56.02	48.69
CircthruCW	02/20/2014	254	120.15	82.21	46.97	52.72	75.03	77.17	56.02	48.68
CircthruCW	02/20/2014	255	120.18	82.18	46.99	52.7	75.44	77.5	55.95	48.64
CircthruCW	02/20/2014	256	120.13	82.78	47.19	52.7	75.44	77.5	56.22	48.69
CircthruCW	02/20/2014	257	120.15	82.86	47.13	52.7	76.04	77.5	56.24	48.66
CircthruCW	02/20/2014	258	120.13	82.83	47.19	52.89	76.09	78.08	56.2	48.69
CircthruCW	02/20/2014	259	120.2	83.46	47.17	52.95	75.46	77.5	56.29	48.56
CircthruCW	02/20/2014	260	120.2	83.46	47.15	52.97	75.58	78.08	56.29	48.56
CircthruCW	02/20/2014	261	120.13	83.36	47.15	52.7	76.04	78.08	56.04	48.66
CircthruCW	02/20/2014	262	120.22	84.06	47.15	52.72	76.09	78.13	56.04	48.58
CircthruCW	02/20/2014	263	120.1	84.42	47.11	52.74	76.09	78.13	56.08	48.58
CircthruCW	02/20/2014	264	120.18	84.27	47.17	52.7	76.54	78.63	56.08	48.68
CircthruCW	02/20/2014	265	120.13	84.32	46.95	52.66	76.45	78.61	56.06	48.68
CircthruCW	02/20/2014	266	120.15	84.92	46.9	52.7	76.59	78.63	56.02	48.58
CircthruCW	02/20/2014	267	120.13	84.92	46.93	52.68	76.54	78.63	56.04	48.64
CircthruCW	02/20/2014	268	120.1	84.9	47.15	52.7	76.59	79.18	55.99	48.66
CircthruCW	02/20/2014	269	120.13	85.5	46.99	52.95	77.19	79.3	56.04	48.66
CircthruCW	02/20/2014	270	120.13	85.45	46.95	52.7	77.19	79.88	56	48.62
CircthruCW	02/20/2014	271	120.18	85.78	47.13	52.7	77.29	79.35	56.08	48.66
CircthruCW	02/20/2014	272	120.22	85.83	47.03	52.7	77.19	79.57	56.04	48.64
CircthruCW	02/20/2014	273	120.15	86.36	46.93	52.7	77.19	79.57	56.06	48.68
CircthruCW	02/20/2014	274	120.15	86.41	47.21	52.91	77.22	79.57	56.24	48.66
CircthruCW	02/20/2014	275	120.13	86.98	47.44	53.16	77.77	80.22	56.28	48.89
CircthruCW	02/20/2014	276	119.89	87.01	47.88	53.68	78.2	80.22	57.15	49.31
CircthruCW	02/20/2014	277	119.91	87.39	48.91	55.42	77.89	79.93	58.48	50.47
CircthruCW	02/20/2014	278	119.53	87.03	50.78	56.57	78.49	80.82	59.97	51.96

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	279	119.55	87.58	51.77	57.38	78.15	80.53	60.9	52.99
CircthruCW	02/20/2014	280	119.48	88.18	51.98	57.47	78.15	80.14	61.07	53.22
CircthruCW	02/20/2014	281	119.55	88.18	52.04	57.46	78.1	81.44	61.09	53.26
CircthruCW	02/20/2014	282	119.58	88.21	51.75	57.3	78.22	81.42	60.88	53.16
CircthruCW	02/20/2014	283	119.65	88.88	51.5	57.24	78.66	81.42	60.86	52.89
CircthruCW	02/20/2014	284	119.53	88.81	51.58	57.24	79.3	81.42	60.82	52.95
CircthruCW	02/20/2014	285	119.5	88.86	51.56	57.01	79.28	81.37	60.53	52.74
CircthruCW	02/20/2014	286	119.6	89.43	51.25	57.03	79.35	82.02	60.41	52.7
CircthruCW	02/20/2014	287	119.53	89.41	51.54	57.03	79.33	82.28	60.43	52.81
CircthruCW	02/20/2014	288	119.55	89.48	51.27	56.99	79.28	81.97	60.39	52.56
CircthruCW	02/20/2014	289	118.93	89.67	51.27	56.76	79.52	81.94	60.39	52.76
CircthruCW	02/20/2014	290	118.95	89.67	51.34	56.78	79.59	82.26	60.43	52.78
CircthruCW	02/20/2014	291	118.93	90.27	51.29	56.78	80.46	82.21	60.16	52.76
CircthruCW	02/20/2014	292	118.98	90.3	51.34	56.55	80.43	82.88	60.16	52.49
CircthruCW	02/20/2014	293	119.29	90.37	51	56.57	80.5	82.93	60.22	52.47
CircthruCW	02/20/2014	294	118.98	90.87	51.21	56.49	80.41	82.86	60.1	52.45
CircthruCW	02/20/2014	295	118.66	90.92	51.05	56.58	80.5	83.48	60.16	52.45
CircthruCW	02/20/2014	296	118.64	90.9	50.86	56.58	80.79	83.48	60.18	52.23
CircthruCW	02/20/2014	297	118.66	91.57	50.76	56.6	80.91	83.48	60.16	52.31
CircthruCW	02/20/2014	298	118.62	91.47	50.82	56.31	81.37	84.03	59.85	52.31
CircthruCW	02/20/2014	299	118.64	91.47	50.84	56.35	81.37	84.1	59.95	52.33
CircthruCW	02/20/2014	300	118.66	92.1	50.76	56.35	81.46	84.42	59.95	52.27
CircthruCW	02/20/2014	301	118.69	92.38	50.8	56.33	82.06	84.3	59.93	51.98
CircthruCW	02/20/2014	302	118.02	92.07	50.88	56.33	81.37	84.73	59.93	52
CircthruCW	02/20/2014	303	117.99	92.36	50.84	56.29	82.02	85.28	59.64	52
CircthruCW	02/20/2014	304	117.99	92.29	50.82	56.31	81.99	85.23	59.68	52.04
CircthruCW	02/20/2014	305	118.09	92.98	50.84	56.35	82.52	85.28	59.68	51.94
CircthruCW	02/20/2014	306	118.02	92.91	50.82	56.26	82.64	85.57	59.62	52.04
CircthruCW	02/20/2014	307	118.09	93.01	50.59	56.37	82.66	85.64	59.68	51.94
CircthruCW	02/20/2014	308	117.42	93.58	50.49	56.35	82.78	85.57	59.64	51.67
CircthruCW	02/20/2014	309	117.46	93.56	50.59	56.29	82.88	86.14	59.68	51.75

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	310	117.44	93.54	50.61	56.28	82.88	86.17	59.6	51.79
CircthruCW	02/20/2014	311	117.46	94.16	50.61	56.33	83.41	86.12	59.66	51.83
CircthruCW	02/20/2014	312	117.54	94.21	50.53	56.1	84.15	86.79	59.49	51.85
CircthruCW	02/20/2014	313	117.49	94.16	50.55	56.1	84.13	86.79	59.51	51.69
CircthruCW	02/20/2014	314	117.51	94.81	50.55	56.1	84.1	87.39	59.52	51.73
CircthruCW	02/20/2014	315	117.46	94.86	50.26	56.08	84.13	86.82	59.51	51.83
CircthruCW	02/20/2014	316	116.89	94.81	50.34	56.12	84.1	87.32	59.51	51.71
CircthruCW	02/20/2014	317	116.82	94.76	50.38	56.04	84.68	87.94	59.21	51.73
CircthruCW	02/20/2014	318	116.79	95.31	50.3	55.99	84.63	87.63	59.16	51.83
CircthruCW	02/20/2014	319	116.89	95.38	50.32	55.83	85.35	87.94	59.23	51.69
CircthruCW	02/20/2014	320	116.82	95.67	50.38	55.83	85.28	88.21	59.21	51.81
CircthruCW	02/20/2014	321	116.91	95.7	50.07	55.87	85.9	88.26	59.21	51.54
CircthruCW	02/20/2014	322	116.74	95.6	50.09	55.79	85.83	88.21	59.16	51.56
CircthruCW	02/20/2014	323	116.86	95.6	50.07	55.81	85.88	88.21	59.18	51.5
CircthruCW	02/20/2014	324	116.79	96.3	50.05	55.85	85.9	88.88	59.23	51.58
CircthruCW	02/20/2014	325	116.26	96.22	50.03	55.79	86.12	89.41	59.1	51.54
CircthruCW	02/20/2014	326	116.26	96.22	50.13	55.81	86.07	89.43	59.18	51.54
CircthruCW	02/20/2014	327	116.34	96.22	50.13	55.6	86.79	89.48	59.23	51.61
CircthruCW	02/20/2014	328	116.22	96.78	50.09	55.54	86.82	89.41	59.14	51.58
CircthruCW	02/20/2014	329	116.36	96.85	50.07	55.6	86.89	89.77	58.96	51.54
CircthruCW	02/20/2014	330	116.24	96.85	50.09	55.56	87.34	89.72	58.91	51.56
CircthruCW	02/20/2014	331	116.36	97.38	50.05	55.58	87.39	89.7	58.92	51.63
CircthruCW	02/20/2014	332	116.29	97.42	50.11	55.58	87.56	89.72	58.92	51.58
CircthruCW	02/20/2014	333	116.29	97.35	50.07	55.6	87.94	90.42	59.02	51.48
CircthruCW	02/20/2014	334	116.26	97.45	50.09	55.29	87.97	90.87	58.91	51.29
CircthruCW	02/20/2014	335	116.34	97.57	49.84	55.35	88.62	90.97	58.98	51.21
CircthruCW	02/20/2014	336	116.24	97.42	49.84	55.33	88.52	90.87	58.91	51.23
CircthruCW	02/20/2014	337	116.29	97.45	49.86	55.35	88.47	91.47	58.96	51.32
CircthruCW	02/20/2014	338	116.31	97.45	49.91	55.33	88.81	91.5	58.92	51.34
CircthruCW	02/20/2014	339	116.31	97.38	49.8	55.33	88.83	92.02	58.89	51.29
CircthruCW	02/20/2014	340	116.19	97.42	49.87	55.29	88.81	92.02	58.92	51.29

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	341	116.02	97.54	49.86	55.33	88.9	92.14	58.94	51.29
CircthruCW	02/20/2014	342	115.98	97.35	49.84	55.33	89.36	92.67	58.65	51.23
CircthruCW	02/20/2014	343	115.93	97.42	49.86	55.31	89.43	92.67	58.65	51.31
CircthruCW	02/20/2014	344	115.93	96.85	49.35	55.12	89.48	92.65	58.75	51.07
CircthruCW	02/20/2014	345	116.02	96.87	49.31	55.37	90.08	93.03	58.69	50.82
CircthruCW	02/20/2014	346	115.95	96.78	49.62	55.08	90.01	92.94	58.67	51.25
CircthruCW	02/20/2014	347	116.26	96.82	49.62	55.1	90.56	93.58	58.69	51.07
CircthruCW	02/20/2014	348	115.93	96.49	49.86	55.08	90.56	93.54	58.46	51.09
CircthruCW	02/20/2014	349	115.88	96.49	49.84	55.06	91.28	93.56	58.4	51.36
CircthruCW	02/20/2014	350	115.95	96.54	49.64	55.1	90.61	93.63	58.52	51.05
CircthruCW	02/20/2014	351	115.93	96.44	49.66	55.06	91.16	94.21	58.46	51.05
CircthruCW	02/20/2014	352	115.98	96.56	49.58	55.1	91.26	94.42	58.46	50.98
CircthruCW	02/20/2014	353	115.98	96.61	49.58	55.08	91.93	94.23	58.52	50.98
CircthruCW	02/20/2014	354	116.34	95.98	49.29	55.13	91.86	94.88	58.5	50.8
CircthruCW	02/20/2014	355	116.02	95.96	49.37	55.1	91.88	94.83	58.54	50.82
CircthruCW	02/20/2014	356	116	96.01	49.35	55.1	91.88	95.38	58.42	50.78
CircthruCW	02/20/2014	357	116.07	95.89	49.41	55.06	92.43	95.31	58.44	50.84
CircthruCW	02/20/2014	358	115.9	95.94	49.35	55.08	92.41	95.34	58.42	50.88
CircthruCW	02/20/2014	359	116	95.36	49.27	55.13	92.77	95.46	58.46	50.74
CircthruCW	02/20/2014	360	115.98	96.01	49.31	55.13	92.77	96.06	58.48	50.8
CircthruCW	02/20/2014	361	115.95	95.31	49.37	55.1	92.77	96.01	58.42	50.8
CircthruCW	02/20/2014	362	116	95.43	49.43	55.1	92.79	96.06	58.52	50.88
CircthruCW	02/20/2014	363	116.02	95.38	49.27	55.12	92.79	95.98	58.52	50.78
CircthruCW	02/20/2014	364	115.93	95.34	49.37	55.15	92.77	96.27	58.5	50.8
CircthruCW	02/20/2014	365	116	95.41	49.35	55.13	93.37	96.44	58.56	50.86
CircthruCW	02/20/2014	366	115.98	95.36	49.31	55.12	93.39	96.32	58.5	50.8
CircthruCW	02/20/2014	367	115.98	95.34	49.33	54.88	93.34	96.37	58.27	50.94
CircthruCW	02/20/2014	368	115.98	95.41	49.31	54.86	93.97	96.94	58.23	50.47
CircthruCW	02/20/2014	369	116	95.43	49.35	54.92	93.39	96.44	58.25	50.9
CircthruCW	02/20/2014	370	116.02	95.31	49.04	54.86	93.32	96.32	58.25	50.57
CircthruCW	02/20/2014	371	116	95.36	49.14	54.84	93.92	96.99	58.29	50.61

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	372	116.6	95.36	49.02	54.88	93.99	96.9	58.25	50.67
CircthruCW	02/20/2014	373	115.98	95.36	49.08	54.86	93.92	96.92	58.25	50.51
CircthruCW	02/20/2014	374	116	95.41	49.08	54.86	93.34	96.9	58.29	50.57
CircthruCW	02/20/2014	375	116.02	95.38	49.08	54.65	93.94	96.32	58.25	50.59
CircthruCW	02/20/2014	376	115.93	95.29	48.89	54.61	93.92	96.87	58.19	50.55
CircthruCW	02/20/2014	377	116	95.38	48.93	54.65	93.97	96.94	58.27	50.57
CircthruCW	02/20/2014	378	115.95	95.31	48.93	54.59	93.25	96.9	57.9	50.47
CircthruCW	02/20/2014	379	115.98	95.94	48.91	54.57	93.9	96.8	57.98	50.32
CircthruCW	02/20/2014	380	116	95.31	48.87	54.63	93.9	96.92	58.02	50.32
CircthruCW	02/20/2014	381	116	95.31	48.93	54.57	93.87	96.8	57.98	50.28
CircthruCW	02/20/2014	382	115.9	95.31	48.87	54.57	93.9	96.82	57.96	50.3
CircthruCW	02/20/2014	383	115.95	95.34	48.89	54.59	93.92	96.25	58.05	50.36
CircthruCW	02/20/2014	384	116	96.03	48.81	54.65	93.92	96.39	58.04	50.26
CircthruCW	02/20/2014	385	116.02	95.98	48.83	54.65	93.92	96.92	58.02	50.28
CircthruCW	02/20/2014	386	115.95	95.43	48.87	54.63	93.97	96.78	58	50.36
CircthruCW	02/20/2014	387	115.93	95.94	48.64	54.61	93.8	96.87	57.9	50.09
CircthruCW	02/20/2014	388	115.88	95.86	48.87	54.57	93.92	96.3	57.86	50.38
CircthruCW	02/20/2014	389	116.02	96.01	48.83	54.67	93.97	96.39	57.96	50.36
CircthruCW	02/20/2014	390	115.95	95.98	48.81	54.69	93.97	96.34	57.76	50.34
CircthruCW	02/20/2014	391	116.07	96.58	48.85	54.63	93.99	96.32	57.78	50.32
CircthruCW	02/20/2014	392	115.98	96.56	48.87	54.63	93.9	96.3	58	50.4
CircthruCW	02/20/2014	393	115.98	96.03	48.81	54.65	93.97	96.3	58	50.38
CircthruCW	02/20/2014	394	116	96.49	48.87	54.65	93.94	96.37	58	50.3
CircthruCW	02/20/2014	395	115.93	96.54	48.93	54.65	93.92	96.27	57.98	50.36
CircthruCW	02/20/2014	396	116	96.44	48.93	54.63	93.85	96.27	58.23	50.57
CircthruCW	02/20/2014	397	115.86	96.8	48.89	54.61	93.92	96.22	58.27	50.59
CircthruCW	02/20/2014	398	115.98	96.85	48.87	54.69	93.37	96.34	58.23	50.57
CircthruCW	02/20/2014	399	115.98	96.85	48.97	54.61	93.87	96.27	58.15	50.63
CircthruCW	02/20/2014	400	116	96.87	48.85	54.65	93.9	96.34	58.27	50.61
CircthruCW	02/20/2014	401	115.95	96.9	48.91	54.69	94.02	96.3	58.21	50.49
CircthruCW	02/20/2014	402	115.95	97.11	49.1	54.63	93.92	96.03	58.25	50.53

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	403	115.98	96.87	49.06	54.67	93.97	96.3	58.27	50.55
CircthruCW	02/20/2014	404	115.9	97.5	49.12	54.86	93.92	96.37	58.27	50.61
CircthruCW	02/20/2014	405	116.05	98.05	49.06	54.86	93.94	95.98	58.17	50.65
CircthruCW	02/20/2014	406	115.98	97.47	49.06	54.84	93.94	96.03	58.23	50.53
CircthruCW	02/20/2014	407	115.95	97.54	49.33	54.86	94.02	96.03	58.21	50.61
CircthruCW	02/20/2014	408	115.95	97.98	49.39	54.83	93.87	95.98	58.21	50.63
CircthruCW	02/20/2014	409	115.98	97.98	49.37	54.81	94.52	96.27	58.13	50.63
CircthruCW	02/20/2014	410	115.95	97.98	49.16	54.88	93.94	95.98	58.21	50.71
CircthruCW	02/20/2014	411	116	98.62	49.14	54.77	93.87	95.98	58.27	50.65
CircthruCW	02/20/2014	412	115.98	98.6	49.12	54.77	93.92	96.27	58.21	50.57
CircthruCW	02/20/2014	413	116.05	98.65	49.14	54.86	93.92	96.32	58.27	50.59
CircthruCW	02/20/2014	414	116.05	98.72	49.02	54.9	94.54	96.3	58.29	50.65
CircthruCW	02/20/2014	415	116.02	98.67	49.12	54.65	94.59	96.37	58.27	50.61
CircthruCW	02/20/2014	416	116	99.27	49.27	54.67	93.99	96.34	58.27	50.63
CircthruCW	02/20/2014	417	116	99.3	49.1	54.63	94.54	96.37	58.31	50.61
CircthruCW	02/20/2014	418	116.02	99.22	48.85	54.61	93.94	96.37	58.23	50.38
CircthruCW	02/20/2014	419	115.98	99.27	49.1	54.65	93.97	96.34	58.27	50.57
CircthruCW	02/20/2014	420	116.02	99.58	49.06	54.71	94.52	96.32	58.27	50.63
CircthruCW	02/20/2014	421	116.02	99.27	49.16	54.63	93.94	96.32	58.29	50.57
CircthruCW	02/20/2014	422	115.98	99.3	49.1	54.63	94.52	96.32	58.25	50.63
CircthruCW	02/20/2014	423	115.47	99.56	48.85	54.65	94.57	96.34	58.25	50.61
CircthruCW	02/20/2014	424	115.98	99.58	49.1	54.67	94.52	96.34	58.27	50.61
CircthruCW	02/20/2014	425	115.95	99.51	48.91	54.67	94.54	96.34	58.17	50.67
CircthruCW	02/20/2014	426	115.95	99.99	48.93	54.61	94.5	96.85	58.17	50.65
CircthruCW	02/20/2014	427	115.9	100.06	48.87	54.63	94.52	96.85	58.23	50.61
CircthruCW	02/20/2014	428	115.88	100.09	48.91	54.63	93.92	96.9	58.25	50.55
CircthruCW	02/20/2014	429	116	100.14	48.85	54.63	94.57	96.94	58.29	50.63
CircthruCW	02/20/2014	430	116.02	100.16	48.83	54.71	95.14	96.94	58.04	50.38
CircthruCW	02/20/2014	431	115.98	100.09	48.89	54.63	95.17	96.85	57.98	50.38
CircthruCW	02/20/2014	432	115.95	100.74	48.91	54.61	94.52	96.92	57.98	50.36
CircthruCW	02/20/2014	433	116.02	100.76	48.83	54.63	94.52	96.94	57.96	50.3

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	434	115.95	100.76	48.93	54.61	95.17	97.59	58	50.42
CircthruCW	02/20/2014	435	115.98	100.69	48.93	54.61	95.1	97.5	57.67	50.38
CircthruCW	02/20/2014	436	115.33	101.02	48.87	54.63	95.74	97.42	57.96	50.38
CircthruCW	02/20/2014	437	115.38	101.29	48.93	54.63	95.17	97.5	57.98	50.42
CircthruCW	02/20/2014	438	115.47	101.26	48.89	54.59	95.65	97.47	57.92	50.38
CircthruCW	02/20/2014	439	115.93	101.26	48.89	54.34	95.12	98	57.96	50.36
CircthruCW	02/20/2014	440	115.98	101.31	48.87	54.34	95.77	98.07	57.71	50.4
CircthruCW	02/20/2014	441	115.98	101.29	48.91	54.61	95.7	98	57.71	50.15
CircthruCW	02/20/2014	442	116	101.38	48.87	54.44	95.79	98.12	57.76	50.42
CircthruCW	02/20/2014	443	116	101.96	48.85	54.69	96.03	98.19	57.75	50.42
CircthruCW	02/20/2014	444	115.93	101.96	48.85	54.67	96.06	98.14	57.76	50.42
CircthruCW	02/20/2014	445	115.93	101.79	48.89	54.57	96.01	98.65	57.98	50.38
CircthruCW	02/20/2014	446	116.02	101.89	48.91	54.63	95.98	98.43	57.98	50.65
CircthruCW	02/20/2014	447	115.95	102.01	48.87	54.67	96.01	98.46	58.11	50.63
CircthruCW	02/20/2014	448	116.05	102.49	48.87	54.55	95.96	98.41	57.94	50.69
CircthruCW	02/20/2014	449	115.93	102.46	49.16	54.67	96.06	98.79	58	50.38
CircthruCW	02/20/2014	450	115.98	102.44	48.91	54.59	96.58	99.03	57.94	50.63
CircthruCW	02/20/2014	451	115.5	102.42	48.87	54.61	96.54	98.94	57.96	50.38
CircthruCW	02/20/2014	452	115.98	102.51	48.95	54.63	95.98	99.03	58	50.4
CircthruCW	02/20/2014	453	115.38	102.49	48.91	54.61	96.63	98.96	57.71	50.07
CircthruCW	02/20/2014	454	115.93	102.42	48.64	54.57	96.56	98.98	57.69	50.15
CircthruCW	02/20/2014	455	115.74	103.14	48.91	54.4	96.63	98.89	57.75	50.07
CircthruCW	02/20/2014	456	116	103.06	48.87	54.34	97.23	99.58	57.69	50.4
CircthruCW	02/20/2014	457	115.95	103.09	48.87	54.36	97.14	99.58	57.73	50.03
CircthruCW	02/20/2014	458	115.95	103.14	48.87	54.42	97.28	99.68	57.75	50.03
CircthruCW	02/20/2014	459	116.02	103.16	48.83	54.4	97.3	99.63	57.82	50.05
CircthruCW	02/20/2014	460	116.05	103.74	48.83	54.42	97.23	99.66	57.73	50.11
CircthruCW	02/20/2014	461	116.02	103.16	48.83	54.42	97.28	100.18	57.8	50.09
CircthruCW	02/20/2014	462	116	103.69	48.91	54.38	97.21	100.18	57.8	50.09
CircthruCW	02/20/2014	463	115.95	103.71	48.62	54.38	98.41	100.14	57.75	50.11
CircthruCW	02/20/2014	464	115.95	103.69	48.6	54.38	97.71	100.18	57.73	50.11

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	465	115.98	103.64	48.66	54.34	98.41	100.21	57.75	50.07
CircthruCW	02/20/2014	466	115.9	103.66	48.64	54.34	98.36	100.76	57.69	50.09
CircthruCW	02/20/2014	467	115.93	104	48.66	54.36	98.41	100.78	57.75	50.03
CircthruCW	02/20/2014	468	115.93	103.98	48.66	54.15	97.69	100.74	57.51	50.11
CircthruCW	02/20/2014	469	115.88	103.62	48.66	54.32	98.38	100.74	57.47	50.07
CircthruCW	02/20/2014	470	116.02	104.07	48.64	54.21	98.48	101.31	57.53	50.05
CircthruCW	02/20/2014	471	116	104.02	48.58	54.19	98.43	101.36	57.3	50.13
CircthruCW	02/20/2014	472	115.93	103.95	48.66	54.11	98.89	101.34	57.22	50.01
CircthruCW	02/20/2014	473	116	104.02	48.69	54.15	99.01	101.34	57.24	50.15
CircthruCW	02/20/2014	474	116	104.67	48.62	54.13	99.32	101.41	57.32	49.86
CircthruCW	02/20/2014	475	115.93	104.6	48.62	53.86	98.94	101.96	57.24	49.87
CircthruCW	02/20/2014	476	115.95	104.62	48.66	53.9	98.96	101.82	57.24	49.82
CircthruCW	02/20/2014	477	116.05	104.55	48.66	53.94	99.27	102.08	57.32	49.89
CircthruCW	02/20/2014	478	116.02	104.67	48.62	54.19	99.2	102.08	57.3	49.86
CircthruCW	02/20/2014	479	115.95	104.62	48.68	54.09	99.25	101.91	57.53	49.82
CircthruCW	02/20/2014	480	116.07	104.65	48.6	54.19	99.32	102.01	57.57	49.78
CircthruCW	02/20/2014	481	116.07	104.58	48.62	53.9	99.87	101.98	57.22	49.87
CircthruCW	02/20/2014	482	115.95	104.62	48.66	53.88	99.32	101.91	57.28	49.87
CircthruCW	02/20/2014	483	116	104.58	48.66	53.9	99.25	102.25	57.28	49.8
CircthruCW	02/20/2014	484	115.98	104.55	48.62	53.86	99.92	102.25	57.17	49.87
CircthruCW	02/20/2014	485	116.07	104.65	48.6	53.94	99.94	102.27	57.28	49.84
CircthruCW	02/20/2014	486	116.1	105.25	48.37	53.9	100.21	102.32	57.34	49.78
CircthruCW	02/20/2014	487	116.07	105.25	48.39	53.88	100.21	102.85	57.28	49.91
CircthruCW	02/20/2014	488	116	105.22	48.37	53.94	100.28	102.3	57.26	49.87
CircthruCW	02/20/2014	489	115.98	105.2	48.33	53.88	100.47	102.27	57.22	49.82
CircthruCW	02/20/2014	490	115.9	105.18	48.35	53.82	100.3	102.82	57.2	49.87
CircthruCW	02/20/2014	491	116.05	105.2	48.4	53.86	100.52	102.87	57.26	49.86
CircthruCW	02/20/2014	492	116	105.3	48.1	53.88	100.52	102.92	57.28	49.91
CircthruCW	02/20/2014	493	116	105.2	48.13	53.95	100.47	102.92	57.24	49.89
CircthruCW	02/20/2014	494	116.02	105.18	48.11	53.94	100.52	102.87	57.09	49.64
CircthruCW	02/20/2014	495	116.02	105.87	48.1	53.7	101.1	103.47	56.99	49.66

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	496	115.95	105.18	48.15	53.65	100.52	103.42	56.93	49.6
CircthruCW	02/20/2014	497	116.02	105.8	48.15	53.92	101.12	103.47	57.09	49.66
CircthruCW	02/20/2014	498	115.95	105.85	48.11	53.92	101.22	103.5	57.09	49.58
CircthruCW	02/20/2014	499	115.9	105.78	48.15	53.84	101.05	104	56.93	49.57
CircthruCW	02/20/2014	500	115.9	105.8	48.15	53.65	101.14	103.5	56.99	49.58
CircthruCW	02/20/2014	501	116	105.85	48.17	53.7	101.14	104.1	57.03	49.62
CircthruCW	02/20/2014	502	115.95	105.8	48.11	53.65	101.07	104.05	56.93	49.53
CircthruCW	02/20/2014	503	115.98	105.8	48.15	53.68	101.07	104.05	57.07	49.62
CircthruCW	02/20/2014	504	115.9	105.8	48.21	53.68	101.07	104	57.05	49.6
CircthruCW	02/20/2014	505	115.93	105.73	48.17	53.61	101.65	104	57.01	49.33
CircthruCW	02/20/2014	506	115.93	105.85	47.86	53.43	101.77	104.07	56.82	49.41
CircthruCW	02/20/2014	507	116.02	105.75	47.96	53.43	102.2	104.67	56.84	49.43
CircthruCW	02/20/2014	508	115.95	105.78	48.13	53.61	101.6	104.65	57.03	49.35
CircthruCW	02/20/2014	509	115.93	106.4	47.92	53.39	101.72	104.6	56.8	49.39
CircthruCW	02/20/2014	510	116.55	106.33	48	53.39	102.22	104.67	56.72	49.39
CircthruCW	02/20/2014	511	115.9	106.4	47.9	53.37	102.32	104.65	56.78	49.33
CircthruCW	02/20/2014	512	115.95	106.4	47.94	53.45	102.3	104.72	56.8	49.37
CircthruCW	02/20/2014	513	116	106.42	47.84	53.43	102.34	104.7	56.64	49.45
CircthruCW	02/20/2014	514	115.93	106.33	47.88	53.43	102.25	105.15	56.53	49.39
CircthruCW	02/20/2014	515	116	106.47	47.88	53.45	102.85	105.22	56.78	49.37
CircthruCW	02/20/2014	516	115.95	106.38	47.96	53.41	102.73	105.22	56.72	49.39
CircthruCW	02/20/2014	517	115.93	106.98	47.9	53.41	102.8	105.22	56.72	49.41
CircthruCW	02/20/2014	518	115.93	106.4	48.15	54.4	102.9	104.94	57.76	50.13
CircthruCW	02/20/2014	519	116.38	106.74	51.27	57.76	102.9	105.51	60.88	53.97
CircthruCW	02/20/2014	520	116.38	106.69	56.06	62.85	102.94	105.87	65.93	59.04
CircthruCW	02/20/2014	521	116.58	106.71	59.68	65.67	103.16	105.54	69.08	60.88
CircthruCW	02/20/2014	522	116.62	106.98	60.96	66.33	103.47	106.11	69.75	61.86
CircthruCW	02/20/2014	523	116.53	106.95	60.9	66.1	103.45	106.11	69.74	61.5
CircthruCW	02/20/2014	524	116.62	107.31	59.62	65	103.54	106.16	68.79	60.88
CircthruCW	02/20/2014	525	116.6	107.29	59.64	65.46	103.57	106.18	68.94	61.19
CircthruCW	02/20/2014	526	116.55	106.66	59.7	65.11	102.82	105.51	68.75	60.82

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	527	116.62	107.26	58.96	64.75	103.76	106.14	68.28	60.16
CircthruCW	02/20/2014	528	116.65	107.34	59.14	64.77	104.12	106.76	68.57	60.34
CircthruCW	02/20/2014	529	116.62	107.26	59.16	64.65	103.81	106.11	68.32	60.14
CircthruCW	02/20/2014	530	116.6	107.26	58.75	64.22	103.76	106.09	67.9	59.87
CircthruCW	02/20/2014	531	115.98	106.66	58.71	64.2	103.78	106.11	68.09	59.95
CircthruCW	02/20/2014	532	115.93	106.74	58.75	64.18	103.76	106.09	67.86	59.97
CircthruCW	02/20/2014	533	115.9	106.66	58.5	63.97	103.76	106.18	67.63	59.68
CircthruCW	02/20/2014	534	116	106.69	58.56	63.97	103.74	106.16	67.59	59.7
CircthruCW	02/20/2014	535	116	106.71	58.52	64.01	103.71	106.23	67.4	59.68
CircthruCW	02/20/2014	536	115.95	106.69	58.25	63.7	103.76	106.11	67.41	59.12
CircthruCW	02/20/2014	537	116	106.71	58.25	63.72	103.74	106.71	67.32	59.41
CircthruCW	02/20/2014	538	116.79	106.66	58.23	63.74	103.69	106.09	67.32	59.25
CircthruCW	02/20/2014	539	115.93	107.07	57.94	63.49	104.36	106.18	67.18	59.2
CircthruCW	02/20/2014	540	116.79	106.98	58.19	63.47	103.86	106.78	67.14	59.21
CircthruCW	02/20/2014	541	116.91	107.53	57.96	63.49	104.38	106.74	67.12	59.14
CircthruCW	02/20/2014	542	116.79	107.65	57.75	63.51	104.43	107.02	66.89	58.92
CircthruCW	02/20/2014	543	116.02	106.98	57.82	63.53	104.31	107.02	66.87	58.94
CircthruCW	02/20/2014	544	115.93	107.48	57.75	63.51	104.31	107	66.85	59
CircthruCW	02/20/2014	545	116.41	107.02	57.75	63.31	104.5	107.05	66.91	59
CircthruCW	02/20/2014	546	116.34	107.02	57.69	63.24	104.43	107.05	66.87	58.92
CircthruCW	02/20/2014	547	116.36	107.02	57.69	63.3	104.36	107.07	66.64	59
CircthruCW	02/20/2014	548	116.26	107.6	57.71	63.02	104.43	107.07	66.7	58.63
CircthruCW	02/20/2014	549	116.36	106.95	57.8	63.02	104.41	106.98	66.6	58.69
CircthruCW	02/20/2014	550	116.17	106.93	57.53	63.01	104.29	107.07	66.56	58.69
CircthruCW	02/20/2014	551	116.34	107	57.53	63.01	105.01	106.98	66.58	58.5
CircthruCW	02/20/2014	552	116.34	107.5	57.34	63.06	104.89	107.05	66.58	58.52
CircthruCW	02/20/2014	553	116.19	107.58	57.28	63.01	104.89	107.29	66.58	58.54
CircthruCW	02/20/2014	554	116.22	107	57.26	63.08	104.43	107.29	66.56	58.38
CircthruCW	02/20/2014	555	116.29	107.5	57.34	63.01	104.94	107.38	66.64	58.46
CircthruCW	02/20/2014	556	116.94	107.62	57.24	62.83	104.91	107.38	66.35	58.5
CircthruCW	02/20/2014	557	116.82	107.58	57.26	62.75	105.18	107.26	66.41	58.44

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	558	116.34	106.98	57.34	62.79	104.89	107.34	66.16	58.46
CircthruCW	02/20/2014	559	116.24	107.55	57.3	62.73	104.96	107.26	66.02	58.4
CircthruCW	02/20/2014	560	116.36	107.65	57.2	62.81	105.03	107.34	66.2	58.46
CircthruCW	02/20/2014	561	116.36	107.05	56.97	62.83	105.06	107.34	66.14	58.23
CircthruCW	02/20/2014	562	116.36	107.58	57.01	62.85	104.98	107.36	66.23	58.27
CircthruCW	02/20/2014	563	116.84	107.58	57.05	62.83	104.86	107.29	66.12	58.21
CircthruCW	02/20/2014	564	116.34	107.62	56.99	62.81	105.61	107.36	66.2	58.27
CircthruCW	02/20/2014	565	116.36	107.6	57.03	62.56	105.66	107.96	66.18	58.31
CircthruCW	02/20/2014	566	116.29	107.55	57.07	62.52	105.61	107.26	66.14	58.25
CircthruCW	02/20/2014	567	116.19	107.53	57.07	62.5	105.56	107.31	66.2	58.19
CircthruCW	02/20/2014	568	116.29	107.6	56.99	62.54	105.54	108.01	66.16	58.29
CircthruCW	02/20/2014	569	116.34	107.67	57.05	62.33	105.56	107.34	65.91	58.33
CircthruCW	02/20/2014	570	116.34	107.55	56.99	62.37	104.96	107.96	65.94	57.98
CircthruCW	02/20/2014	571	116.34	107.58	56.8	62.37	105.63	107.96	65.94	57.98
CircthruCW	02/20/2014	572	116.24	107.58	56.76	62.33	105.49	107.96	65.94	58.04
CircthruCW	02/20/2014	573	116.36	107.53	56.88	62.33	105.56	107.89	65.87	57.8
CircthruCW	02/20/2014	574	116.36	107.05	56.72	62.37	105.61	107.98	65.94	57.82
CircthruCW	02/20/2014	575	116.26	107.62	56.76	62.39	105.56	107.31	65.96	57.76
CircthruCW	02/20/2014	576	116.31	107	56.62	62.27	105.54	107.34	65.89	57.76
CircthruCW	02/20/2014	577	116.26	106.95	56.58	62.25	105.54	107.98	65.85	57.71
CircthruCW	02/20/2014	578	116.31	107.07	56.51	62.1	105.68	107.36	65.65	57.71
CircthruCW	02/20/2014	579	116.36	106.98	56.53	62.14	105.63	107.38	65.69	57.73
CircthruCW	02/20/2014	580	116.31	107.02	56.53	62.1	106.21	108.01	65.69	57.78
CircthruCW	02/20/2014	581	116.6	107	56.58	62.1	106.14	107.94	65.67	57.73
CircthruCW	02/20/2014	582	116.36	106.95	56.62	62.04	106.16	107.34	65.65	57.75
CircthruCW	02/20/2014	583	116.29	107	56.53	62.06	106.21	107.94	65.69	57.75
CircthruCW	02/20/2014	584	116.26	106.45	56.55	62.08	106.26	107.89	65.35	57.51
CircthruCW	02/20/2014	585	116.31	106.06	56.35	62.06	105.56	107.91	65.46	57.49
CircthruCW	02/20/2014	586	116.24	106.02	56.33	62.02	105.51	107.86	65.31	57.46
CircthruCW	02/20/2014	587	116.19	106.11	56.33	62.1	106.23	107.91	65.38	57.51
CircthruCW	02/20/2014	588	116.38	105.56	56.31	62.08	106.16	107.96	65.36	57.55

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	589	116.29	105.44	56.29	61.98	106.09	107.91	65.38	57.57
CircthruCW	02/20/2014	590	116.24	104.84	56.29	61.83	106.18	107.86	65.4	57.51
CircthruCW	02/20/2014	591	116.34	104.89	56.37	61.86	106.11	108.8	65.35	57.34
CircthruCW	02/20/2014	592	116.29	103.66	56.35	61.77	106.14	108.18	65.44	57.22
CircthruCW	02/20/2014	593	116.19	103.66	56.31	61.81	106.21	108.15	65.36	57.28
CircthruCW	02/20/2014	594	116.31	103.69	56.37	61.81	106.11	108.22	65.42	57.28
CircthruCW	02/20/2014	595	116.31	103.09	56.12	61.54	106.11	108.15	65.19	57.24
CircthruCW	02/20/2014	596	116.24	102.78	56.06	61.61	106.18	107.6	65.15	57.32
CircthruCW	02/20/2014	597	116.22	102.78	55.89	61.57	106.76	108.3	65.11	57.28
CircthruCW	02/20/2014	598	116.22	102.78	56.33	61.59	106.18	108.25	65.19	57.32
CircthruCW	02/20/2014	599	116.36	102.27	56.1	61.63	106.18	108.27	65.25	57.32
CircthruCW	02/20/2014	600	116.31	101.62	56	61.63	105.97	108.3	65.21	57.32
CircthruCW	02/20/2014	601	116.41	101.55	56.04	61.55	105.51	108.3	65.15	57.38
CircthruCW	02/20/2014	602	116.29	101.62	56.08	61.57	106.18	108.22	65.23	57.32
CircthruCW	02/20/2014	603	116.29	100.98	56.12	61.54	105.49	108.22	64.98	57.28
CircthruCW	02/20/2014	604	116.38	100.4	55.81	61.55	106.11	108.25	64.86	57.09
CircthruCW	02/20/2014	605	116.17	100.42	56.12	61.59	105.66	108.18	64.9	57.03
CircthruCW	02/20/2014	606	115.71	100.47	55.75	61.63	105.68	108.25	64.94	57.07
CircthruCW	02/20/2014	607	115.69	100.45	55.79	61.38	105.58	107.7	65.02	57.01
CircthruCW	02/20/2014	608	116.34	100.4	55.79	61.32	105.54	107.6	65.02	57.03
CircthruCW	02/20/2014	609	116.24	100.11	55.87	61.32	104.94	107.67	64.94	56.99
CircthruCW	02/20/2014	610	116.24	100.04	55.81	61.3	105.46	107.65	64.96	57.01
CircthruCW	02/20/2014	611	116.31	100.09	55.83	61.34	105.9	107.6	64.94	56.97
CircthruCW	02/20/2014	612	115.74	100.09	55.89	61.09	105.37	107.67	64.69	57.01
CircthruCW	02/20/2014	613	115.64	100.04	55.83	61.07	105.2	107.62	64.59	56.97
CircthruCW	02/20/2014	614	115.66	100.06	55.83	61.11	105.2	107.02	64.73	56.97
CircthruCW	02/20/2014	615	115.69	99.61	55.79	61.11	104.7	107.17	64.63	56.86
CircthruCW	02/20/2014	616	115.69	99.49	55.79	61.11	104.62	107.1	64.67	56.82
CircthruCW	02/20/2014	617	116.05	99.56	55.56	61.13	104.77	107.07	64.75	56.86
CircthruCW	02/20/2014	618	116	99.58	55.56	61.15	104.82	106.54	64.73	56.8
CircthruCW	02/20/2014	619	116.05	99.51	55.58	61.19	104.7	106.5	64.67	56.57

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	Date	Interval	T_HWS	T_CWS	P_HWS	P_CWS	T_SV3_C	T_SV3_H	P_SV3_C	P_SV3_H
CircthruCW	02/20/2014	620	115.88	99.49	55.33	61.09	104.65	106.42	64.77	56.57
CircthruCW	02/20/2014	621	116.02	99.51	55.39	61.13	104.07	106.4	64.67	56.78
CircthruCW	02/20/2014	622	116.05	99.58	55.31	61.15	104.07	106.21	64.75	56.76
CircthruCW	02/20/2014	623	115.93	99.49	55.37	61.13	103.47	105.54	64.71	56.49
CircthruCW	02/20/2014	624	116	99.51	55.17	61.09	103.66	105.56	64.63	56.53
CircthruCW	02/20/2014	625	115.9	99.54	55.35	60.86	103.52	105.51	64.71	56.51
CircthruCW	02/20/2014	626	116	99.03	55.37	60.9	103.47	105.56	64.46	56.55
CircthruCW	02/20/2014	627	116.02	99.56	55.39	60.86	102.82	105.03	64.42	56.64
CircthruCW	02/20/2014	628	116.02	99.56	55.35	60.86	102.9	104.94	64.55	56.57
CircthruCW	02/20/2014	629	115.98	99.58	55.33	60.92	102.97	104.41	64.53	56.53
CircthruCW	02/20/2014	630	116.02	98.91	55.44	60.9	102.34	104.31	64.49	56.28
CircthruCW	02/20/2014	631	115.93	98.89	55.12	60.82	102.22	103.69	64.44	56.57
CircthruCW	02/20/2014	632	116.02	99.58	55.1	60.88	102.08	104.38	64.2	56.39
CircthruCW	02/20/2014	633	116.02	99.61	55.06	60.86	102.37	103.74	64.15	56.64
CircthruCW	02/20/2014	634	116.07	98.96	55.1	60.9	101.94	103.57	64.3	56.33
CircthruCW	02/20/2014	635	116	98.96	55.1	60.92	101.5	102.9	64.32	56.31
CircthruCW	02/20/2014	636	116	98.89	55.13	60.88	101.38	103.47	64.3	56.29
CircthruCW	02/20/2014	637	115.98	98.89	55.12	60.59	101.29	102.75	64.24	56.41

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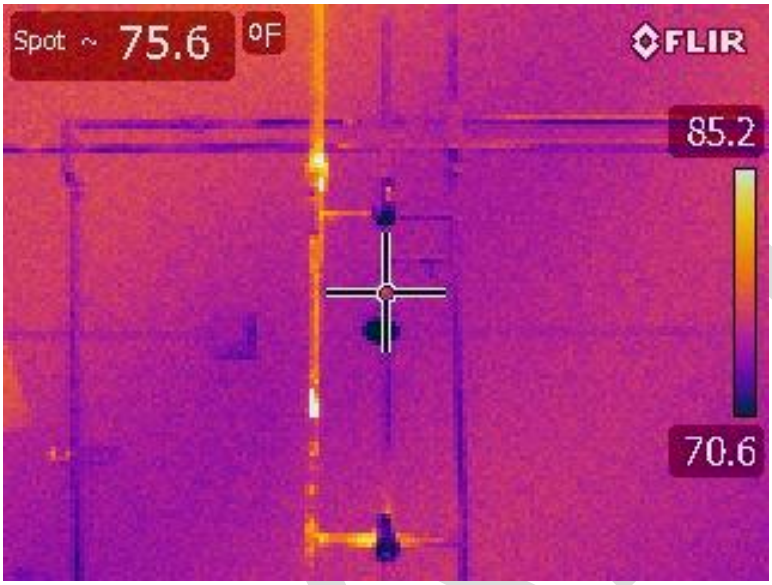
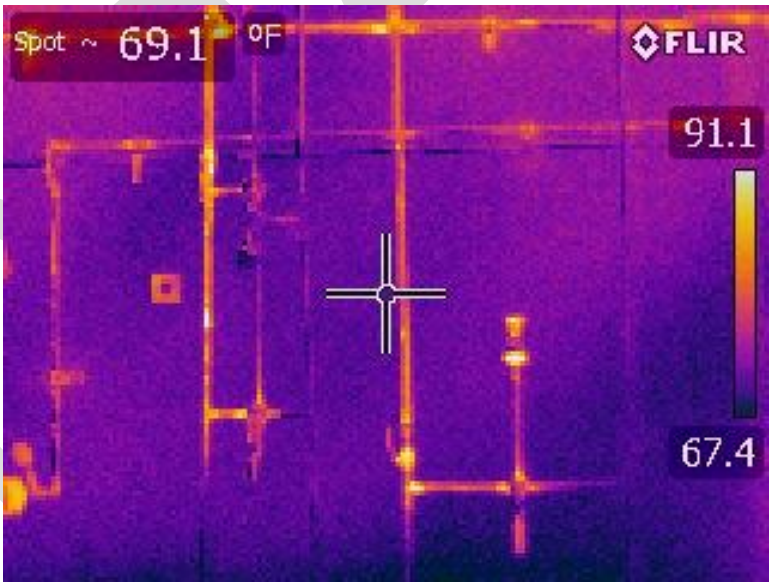
APPENDIX D:
Photos

The following pictures and illustrations were part of data collection and the lab experiments conducted. They were also part of the progress reports published previously.



Thermal imaging showing Hot Water line in one shower system.



Thermal image showing hot water line in multiple shower / faucet system

Image showing lab setup.

Thermal image showing hot water return line.

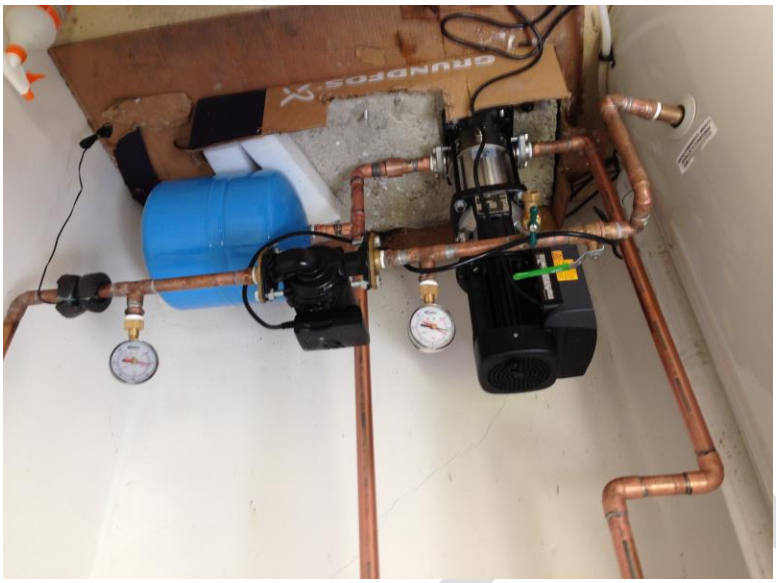
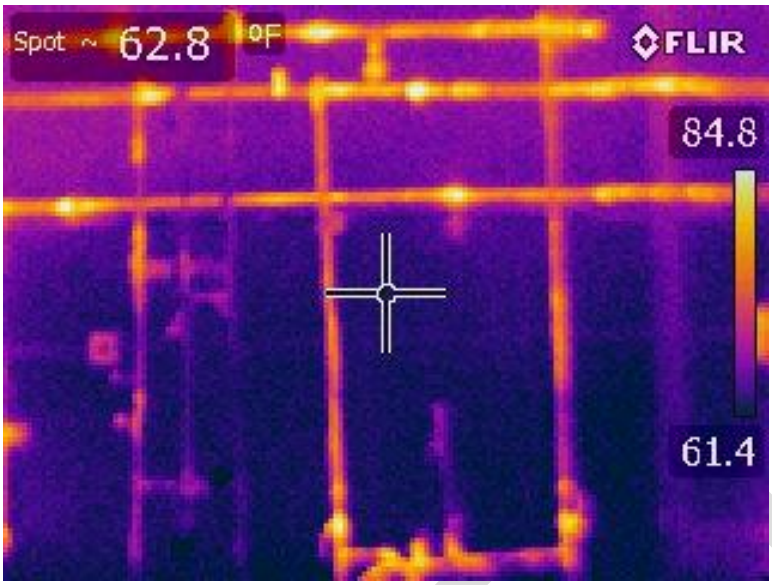


Image of pump used at the return line.

Image showing pressure gauges at the return line.



Thermal image showing cross-over in the shower system.

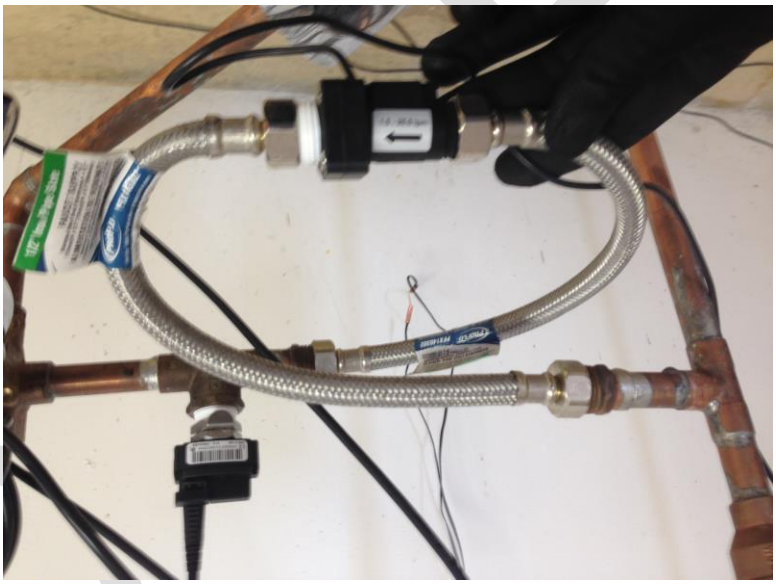


Image showing the flow sensors usage.

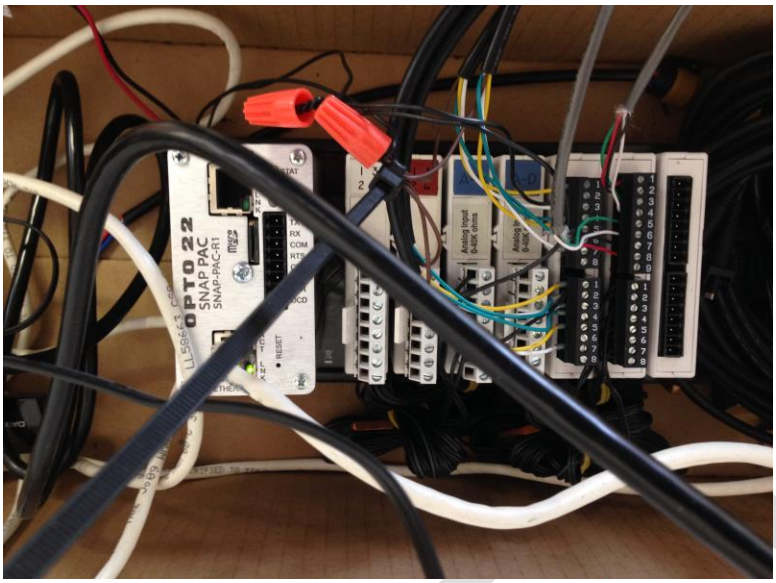


Image showing the DAQ

Image showing the pressure reducing valve and the corresponding loop.

APPENDIX E:
Best Practice for Detecting Crossover

This section refers to the following manual attached, in its entirety, prepared by Enovative Group Inc for detecting crossovers:

Derek, Zobrist; Gabriel Ayala; "The Crossover Detection Instruction Manual"; Enovative Group Inc.; CEC PIER Grant Contract No. PIR-12-030; 2013.

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APPENDIX F:
Equipment Specs

This sections contains the specification documents for the following equipment used in the lab setup:

- Cyclone A.O. Smith water heater
- ProFlo Flow meter
- Opto22 Logic Power Supply SNAP PAC R1
- DigiFlow 6710M flow sensor
- WATTS 0-200 PSI pressure gauge
- Grundfos UPS26-99BFC
- MOEN Shower Valve Pressure Balance
- MOEN Shower Valve

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