



Energy Conservation Analysis

Tests Conducted On
Underlying Technology For

PowerSentry™-CA

Date: 06/18/04

CONFIDENTIAL

June 18, 2004

EXECUTIVE SUMMARY

Arizona State University Pilot Study

The attached technical report summarizes the Energy Saving Performance of the *PowerSentry™-CA* energy saving controls which were installed on three American Standard package units at Arizona State University. The *PowerSentry™* controls were installed on units #76, #77 and #79 at the Facilities Services Building on the Tempe Campus of ASU. All three units served the Building Services area. The validation data was collected from May 14, 2004 to June 10, 2004, a total of 28 days. The test data was collected using "alternating day" methodology which is describe later in this report. Detailed data on solar load, outdoor temperature and indoor temperature was also collected and is part of this final report.

The systems were programmed to operate Monday through Friday and are controlled by "set back" thermostats. The thermostats on units #77 and #79 were set to 74 degrees during the day and 80 degrees during nighttime hours. The thermostat on unit #76 was set to 80 degrees for both day-time and night-setback operation. The test data in this report reflects a reduction in run-time for units #77 & #79. Unit #76 had a total run time during the test period of only 4 minutes and 3 seconds which occurred on May 18th. This was caused by the thermostat setting being set higher than the other two units that serve the same area. As a result, there was no test data to analyze for this unit. **Both of the 4 ton systems (#77 and #79) realized significant reductions in compressor run-times due to the *PowerSentry™* controls of almost 12% for each unit.** These run time reductions were achieved without noticeable temperature excursions in the office space. The outside temperature data collected during the test period revealed that there were 6% more cooling degree-days when the *PowerSentry™* control was in the circuit. **The 12% reduction in total run time was achieved without any compensating adjustment for the warmer temperatures on the days when the *PowerSentry™* controls were "On".**

The individual reports contain the documentation that supports the summary results and further details the specific length of each test as well as documenting the overall temperature performance and predictability of the two systems *after the *PowerSentry™* affect.*

This validation analysis clearly shows the *PowerSentry™* controls deliver above the minimum guaranteed savings of 10%... This improvement in operational efficiency was achieved while providing consistent and predictable space comfort.

The *PowerSentry™* Energy Saving Controls will deliver the following benefits to Arizona State University and come with a 15 year warranty against manufacturing defects.

- **Guaranteed Energy Consumption Reductions**
- **Reduced Wear and Tear from excessive on/off cycling**
- **Consistent Temperature Performance**
- **No Maintenance or Programming**
- **Low Upfront Cost**

EQUIPMENT USED FOR TESTING PURPOSES

Specific timing and data logging devices are used to gather detailed information about the unit(s) being evaluated. Each device has been carefully selected for its reliability, capability and function. The individual devices used are explained below.

1. TIME CLOCK:

Manufacturer: Tork

Model: 8007V-0

The clock is used to switch the *PowerSentry™* product in and out of the circuit. This is done on a 24 hour basis. The result is that the *PowerSentry™* product is in control ("in" the circuit) one day and not in control ("out" of circuit) the next day. A 14 day time clock was selected so that a complete alternation of days that *PowerSentry™* is in control would result.

2. CURRENT SWITCH:

Manufacturer: Veris Industries

Model: Hawkeye 608/908

The current switch is used to monitor when current is being drawn by the cooling/refrigeration compressor or heating burner. When current is sensed it is "On" when no-current is sensed it is off "OFF". The current switch is used in conjunction with the "Change-of-State" data logger.

3. "CHANGE-OF-STATE" DATA LOGGER:

Manufacturer: Onset Computer Corp.

Model: H06-001-02

This device monitors and logs the "change-of-states" (the on / off status) of the unit being tested. It is used in conjunction with the CURRENT SWITCH, above, and time and date-stamps (logs) each change of status. By processing the logged data, the durations for each cycle can be determined.

4. "LIGHT INTENSITY" DATA LOGGER:

Manufacturer: Onset Computer Corp.

Model: HL1

This data logger is used to monitor and log Light Intensity and is used to determine the solar-load influence on the facility.

5. "T/Rh "DATA LOGGER:

Manufacturer: Onset Computer Corp.

Model: H08-003-02

This data logger is used to monitor and log the temperature and relative humidity in the conditioned space.

6. "TEMPERATURE" DATA LOGGER:

Manufacturer: Onset Computer Corp.

Model: H08-001-02

This data logger is used to monitor and log the outdoor air temperature, and is used to determine the degree-day influence on the facility

WHAT DATA IS COLLECTED

Linking all of the above together with the *PowerSentry™* product being "in" and "out" of the circuit, on alternating days, yields the following data:

- How many on/off cycles per day.
- Total "on time" per cycle, per day.
- Total "off time" per cycle, per day.
- What the solar load of the facility was during the test period.
- What the relative humidity in the conditioned space was during the test period
- What the temperature of the conditioned space was during the test period
- What the outdoor air temperature was during the test period

How the Data Is Analyzed

Upon completion of the test, all the data is evaluated to calculate the reduction of consumption (savings).

Short-term testing analysis can only be performed properly by the elimination and reduction of as many variables as possible and through the analysis of the data on a statistical basis. The alternating "in" circuit / "out" of circuit testing has the advantage of minimizing the variations due to time-sensitivity, day-of-week sensitivity, degree-day effects, etc.

In order to properly evaluate the data, the following must be determined:

1. A baseline must be established. Baseline consumption data is the "use" or consumption information that is unaffected by the *PowerSentry™* economizer ("out" of circuit). This may be derived during the test (which is what is done here) or from historical records. The advantage of deriving the base-line during the test, is that site specific degree-day and solar data may be determined as opposed to weather-service data that may or may not be indicative of the test site.
2. It is necessary to determine what effects or influences are caused by solar load and degree-day variations. This is done by performing a statistical analysis on the solar and degree-day data collected during the base-line phase.
3. In order to properly compare the two consumption cases (*PowerSentry™* "in" and "out" of circuit), and determine the savings, it is necessary to adjust (or "normalize") the data collected during the "in" circuit phase. The consumption data collected when the *PowerSentry™* economizer was "in" circuit is "normalized" by compensating for the effects of the solar and degree-day influences that occurred during the same phase of the test. This is accomplished by applying the statistical analysis results of the solar and degree-day influences (collected during the base-line phase) as a means to compensate for the solar and degree-day variations that occurred during the "in" circuit phase of the test.
4. The normalized consumption data acquired during the "in" circuit phase is compared to the base-line data and the savings determined.



712 US Hwy One
Suite 200
North Palm Beach, FL 33408

Test Report

Report No. 12129-1
Date: 6/18/2004

Customer
Energy Equities Inc.

Test Site Location
Arizona State University University Services Building Tempe, AZ

Test Type:	<input type="checkbox"/> HEATING	<input checked="" type="checkbox"/> AIR CONDITIONING	<input type="checkbox"/> REFRIGERATION	<input type="checkbox"/> OTHER					
Product Tested:	<input type="checkbox"/> HWR	<input type="checkbox"/> LTH	<input type="checkbox"/> LTC	<input type="checkbox"/> CH2O	<input type="checkbox"/> CST	<input type="checkbox"/> RA	<input checked="" type="checkbox"/> CA	<input type="checkbox"/> REF	<input type="checkbox"/> OTHER

Type of Equipment
HVAC Unit Tagged #79 (Package Rooftop Heat Pump) Manufacturer: American Standard Model: WCP048F400AB Serial #: 2341L7J2H Capacity/SetPt: Day: 74 Degrees Night: 80 Degrees Tons, BTU, HP: 4 Ton Area Served: Building Services Act. V, Amps, Ph: 479 VAC, 3.2 Amps, 3 phase

Test Dates
Start Date: 5/14/2004
End Date: 6/10/2004
No. of Days in Test: 28

COMPRESSOR RUN-TIME
PowerSentri™ ON-DAYS: 110:08:40 <input checked="" type="checkbox"/> in HRS.
PowerSentri™ OFF-DAYS: 123:05:48 <input type="checkbox"/> in MIN.
RUN-TIME was reduced by: 11.76%

BURNER USAGE FACTOR
PowerSentri™ ON-DAYS: 33%
PowerSentri™ OFF-DAYS: 37%

COOLING DEGREE DAYS (for test period)
PowerSentri™ ON-DAYS: 313
PowerSentri™ OFF-DAYS: 295
TOTAL DEGREE-DAYS: 607
It was 6.00% Colder on the On-Days

SOLAR LOAD COMPENSATION
PowerSentri™ ON-DAYS: 317
PowerSentri™ OFF-DAYS: 318
It was <1% Sunnier on the OFF-Days

Adj. Savings = 11.76%

Comments: Due to the fact the area served was on the first floor; outside influences, both temperature and solar, were found to have very little bearing on the test results. As such, these influences were not needed to normalize the data for the savings calculation



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Test Report

Report No. 12129-2
Date: 6/18/2004

Customer
Energy Equities Inc.

Test Site Location
Arizona State University University Services Building Tempe, AZ

Test Type:	<input type="checkbox"/> HEATING	<input checked="" type="checkbox"/> AIR CONDITIONING	<input type="checkbox"/> REFRIGERATION	<input type="checkbox"/> OTHER					
Product Tested:	<input type="checkbox"/> HWR	<input type="checkbox"/> LTH	<input type="checkbox"/> LTC	<input type="checkbox"/> CH2O	<input type="checkbox"/> CST	<input type="checkbox"/> RA	<input checked="" type="checkbox"/> CA	<input type="checkbox"/> REF	<input type="checkbox"/> OTHER

Type of Equipment
HVAC Unit Tagged #77 (Package Rooftop Heat Pump) Manufacturer: American Standard Model: WCP048F400AB Serial #: 2341PGK2H Capacity/SetPt: Day: 75 Degrees Night: 80 Degrees Tons, BTU, HP: 4 Ton Area Served: Building Services Act. V, Amps, Ph: 480 VAC, 3.2 Amps, 3 phase

Test Dates
Start Date: 5/14/2004
End Date: 6/10/2004
No. of Days in Test: 28

COMPRESSOR RUN-TIME
PowerSentri™ ON-DAYS: 85:06:31 <input checked="" type="checkbox"/> in HRS.
PowerSentri™ OFF-DAYS: 95:17:36 <input type="checkbox"/> in MIN.
RUN-TIME was reduced by: 11.97%

BURNER USAGE FACTOR
PowerSentri™ ON-DAYS: 25%
PowerSentri™ OFF-DAYS: 28%

COOLING DEGREE DAYS (for test period)
PowerSentri™ ON-DAYS: 313
PowerSentri™ OFF-DAYS: 295
TOTAL DEGREE-DAYS: 607
It was 6.00% Colder on the On-Days

SOLAR LOAD COMPENSATION
PowerSentri™ ON-DAYS: 317
PowerSentri™ OFF-DAYS: 318
It was <1% Sunnier on the OFF-Days

Adj. Savings = 11.97%

Comments: Due to the fact the area served was on the first floor; outside influences, both temperature and solar, were found to have very little bearing on the test results. As such, these influences were not needed to normalize the data for the savings calculation