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Laboratory Evaluation of the Seeley Climate Wizard Indirect Evaporative Cooler

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Testing was conducted to evaluate the performance of an early production model of the Climate Wizard indirect evaporative cooler from Seeley International. Indirect evaporative coolers make use of the inexpensive cooling derived from the evaporation of water, but do not add moisture to the outside air supplied to the conditioned space.

A test plan was developed based on the previous testing done on other evaporative coolers, including a direct evaporative cooler from the same manufacturer (Breezair Icon). A test condition matrix was established to evaluate system performance over a range of environmental conditions, which would capture the cooling design conditions for several locations in the PG&E service territory. Other tests were conducted to determine its sensitivity to supply air external resistance and fan speed.

Some key test results for this unit are summarized in *Table 1*. (For a more thorough description of the table contents and a comparison with other evaporative cooling systems, refer to Table 4, of which this is a subset.) These results are all presented at the maximum fan speed, and the efficiency (as measured by the ECER number) increases significantly at lower speeds due to fan affinity laws and an improvement in system effectiveness.

Table 1: Average Unit Performance at Maximum Fan Speed

Supply External Resistance [IWC (Pa)]	0	0.3 (75)
Supply Airflow [CFM (l/s)]	1,610 (760)	1,350 (640)
Total Unit Power (W)	1,350	1,370
Effectiveness [at ≥ 25°F (14 K) WBD]	91%	100%
CA T20 ECER [Btu/Wh (COP)]	N/A	12.4 (3.6)

Primary funding for the laboratory testing was provided through PG&E's Emerging Technologies Program, with co-funding from Southern California Edison.

Addendum

Following the end of the laboratory performance testing and analysis, the evaluation unit was sent to the Western Cooling Efficiency Center (http://wcec.ucdavis.edu/). (The evaluation unit was actually on loan from them.) An internal inspection determined that at some time in transit the indirect evaporative cooling media had shifted, opening a passage through which the intake air could bypass the media and mix with the supply air that is cooled. This provides an explanation for why the supply temperature and effectiveness numbers measured during this testing were less than what Seeley had predicted (assuming that this shift had happened prior to its delivery to PG&E). Seeley is reportedly taking steps to prevent this problem happening in new releases.

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INTRODUCTION

Background

Evaporative cooling technologies offer an attractive alternative to conventional compressor-based air conditioners in arid climates because they can provide some level of comfort cooling for a fraction of the energy consumption. Most evaporative cooling systems are of the “direct” variety, where outside air is passed through wetted pads producing direct contact between air and water. The main drawback to direct evaporative cooling systems is that they trade temperature for humidity, with the result often being a cool yet clammy environment that may not feel comfortable to most people. One way around this problem is to use the evaporatively cooled air to cool a secondary air stream through a heat exchanger, where the secondary air stream does not see an increase in moisture. While this “indirect” method offers many advantages in terms of comfort, this comes at the cost of the extra power needed to move a second air stream. Indirect evaporative cooling thus represents an intermediate point between direct systems and compressor air conditioning in the trade-offs between comfort and cost of operation. Also, indirect components can be combined with compressor air conditioning to achieve very high efficiencies while delivering comfort cooling that is equal to conventional air conditioning.

Seeley International Pty. Ltd. (www.seeleyinternational.com) is an Australian-based manufacturer of evaporative cooling and gas heating appliances. Their product line includes a wide range of direct evaporative cooling products, from small portable appliances, to whole house ducted systems and large industrial products. The company has recently begun development of a vertical indirect evaporative cooler for the residential market. Early prototypes have undergone laboratory testing and pilot installations in Australia, with attractive results. Originally called the DriCool system, the product has been re-branded as the Climate Wizard for distribution. The original horizontal configuration is designed for the commercial market. This report describes PG&E’s laboratory testing of a vertical Climate Wizard just becoming available for import.

Prior Research

PG&E recognizes evaporative cooling systems as an alternative to compressor-based air conditioning that will help reduce summer peak demand, and promotes this technology through rebates, informative brochures, and education programs. PG&E’s Applied Technology Services (ATS) has evaluated several evaporative cooling products to support these programs, including direct, indirect and combination systems. The Seeley Breezair Icon direct evaporative cooler was one of the units tested. The results obtained from the previous tests provide a source for comparison data.

Objectives

The objective of this project was to assess the steady state performance of this indirect evaporative cooling unit, as defined by:

- airflow,
- evaporation (or wet-bulb) effectiveness,
- power demand,
- cooling capacity and efficiency,

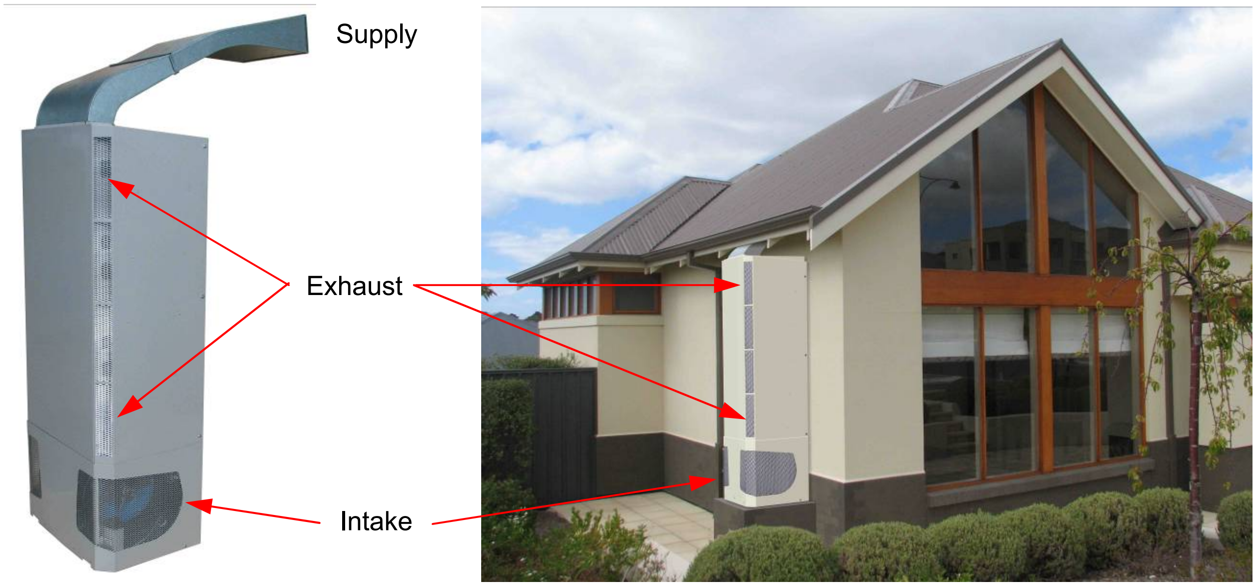
as a function of the variables:

- intake air temperature and humidity,
- external resistance to supply airflow,
- fan speed.

System Description

Figure 1 shows two images of the Climate Wizard, provided by Seeley International. The original DriCool system was a horizontal model, while the unit shown (and the tested model) has a vertical flow path. This new design was developed so that the unit can be attached to the side of a house (as shown in the second photograph) and have a relatively small footprint. Because of the small temperature differences involved, indirect systems need to have a large amount of heat exchange surface area to be effective, and are thus much larger than direct systems. In this unit, outside air is drawn in by a single centrifugal fan at the bottom of the unit, which forces all of the air through the dry side of their indirect evaporative cooler (IEC) module. Like their Breezair Icon unit, this fan is variable speed to provide only as much airflow as needed by the conditioned space. As the air exits the IEC module, it splits in two directions. The supply airflow exits vertically through a duct that necks down to pass through the frieze block space between attic rafters on its way to the conditioned space. A smaller exhaust air stream reverses direction to pass down through the wetted side of the indirect cooling module, and create the cooling medium for heat transfer with the intake air. The exhaust air then exits to the outside through vents along the two front corners. Water is delivered to the wetted media by a pump from a reservoir near the fan. The reservoir also has a flush valve, which is operated periodically to control the buildup of minerals as water is evaporated, and to drain the system when not in use.

Figure 1: Prototype Vertical Climate Wizard



Photos provided by Seeley International

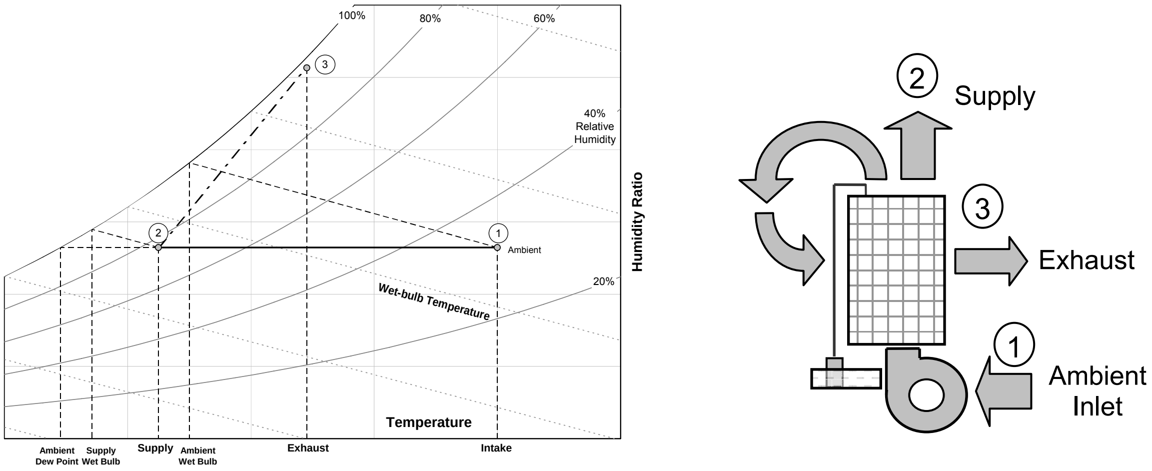
The unit tested is slightly different from the model shown in the photographs. Rather than the open intake at the bottom as shown, ducts have been attached to both sides to move the intakes to the top of the unit in order to reduce the chance for recirculation of the exhaust air to the intake. (The exhaust air has a downward velocity vector due to the change in direction through the wet side of the IEC and a slightly higher density than the outside air.)

Process Description and Performance Characteristics

Figure 2 shows a diagram of the cooling process in the Climate Wizard system on a psychrometric chart. Outside air (1) is drawn in by a blower, and passes through the dry side of the IEC. At this point (2), the airflow splits between supply and exhaust air streams. The supply air is delivered directly from this stage to the space, with the ductwork providing enough resistance to direct part of the airflow through the exhaust path. The exhaust air passes through the wetted side of the IEC (2-3) on its way back outside. The path of the exhaust air shows a combined increase in temperature and moisture (humidity ratio) as heat is absorbed from the exhaust and intake air to evaporate water.

In a direct evaporative cooler, sensible heat (temperature) is traded for latent heat (moisture) obtained from the vaporization of water. In an ideal direct evaporative cooler, the outlet air will become fully saturated (100% relative humidity) at what is referred to as the wet-bulb temperature (shown as a diagonal line on the psychrometric chart). Sensible cooling of a stream of air not only reduces its dry-bulb temperature, but also its wet-bulb temperature. The Climate Wizard takes advantage of this by making the airflow split after the heat exchange rather than before, resulting in a lower heat sink temperature. For an ideal indirect evaporative cooler (i.e. with infinite heat exchange area) using only ambient air, the limiting temperature is found by extending the process horizontally again to 100% relative humidity to the ambient dew point temperature.

Figure 2: Climate Wizard Indirect Evaporative Process



System Performance Measures

There are a number of parameters used to describe the performance of an evaporative cooling system. Most of these have been used in the previous laboratory testing, and may be used to compare the systems. These metrics include:

- Wet-bulb Effectiveness:

$$\text{Effectiveness } (\varepsilon) = \left(\frac{T_{db,in} - T_{db,out}}{T_{db,in} - T_{wb,in}} \right) \times 100\% \qquad \text{(Equation 1)}$$

where $T_{db_{in}}$ and $T_{wb_{in}}$ are the intake dry and wet-bulb temperatures, respectively, and $T_{db_{out}}$ is the dry-bulb temperature at the air outlet. The effectiveness can also be described as the ratio of the sensible cooling of the intake air to its wet-bulb depression.

The wet-bulb effectiveness is the primary metric for describing the performance of direct evaporative coolers, since their limiting outlet temperature is the wet-bulb temperature of the entering air. The effectiveness describes how close the system comes to achieving this limit. In an indirect evaporative cooler, both the dry- and wet-bulb temperatures are reduced, which can be taken advantage of in the system design. Indirect systems can often be designed to produce supply air temperatures below the entering wet-bulb temperature, resulting in an effectiveness better than 100%.

Recognizing that the ultimate adiabatic limiting temperature of an indirect system with a single air intake is the entering dew point temperature, a new parameter is proposed to describe how well the indirect system is performing:

$$\text{"Indirect" Effectiveness } (\varepsilon) = \left(\frac{T_{wb,in} - T_{wb,out}}{T_{wb,in} - T_{dp,in}} \right) \times 100\% \qquad \text{(Equation 2)}$$

By using the relative change in wet-bulb temperature, this parameter results in a value of zero for a direct evaporative cooler.

- Room Capacity:

$$Room\ Capacity\ (Btu/hr) \approx 1.08 \times CFM \times (Tdb_{room} - Tdb_{supply}) \qquad \text{(Equation 3)}$$

where 1.08 is a units conversion factor combining standard air density and specific heat (0.075 lb/ft³ × 0.24 Btu/lb-°F × 60 min/hr), CFM is the flow rate of air supplied by the unit in cubic feet per minute, Tdb_{supply} is the discharge dry-bulb temperature of the test unit, and Tdb_{room} is an assumed indoor space condition in °F. The selected room temperature is **80°F** (26.7°C) to be consistent with the ECER metric below. The Australian evaporative cooler testing standard (Reference 3) uses the same basic equation in SI units with a reference room temperature of 27.4°C (81.3°F). Once the cooling capacity is determined, an energy efficiency ratio (EER) may be determined by dividing it by the total input power in watts.

This formula is derived from the equation used for calculating the sensible capacity of a typical air conditioner, where the room temperature in this case would be the return air temperature to the evaporator coil. The standard air conditioner rating conditions also have a return air temperature of 80°F. However, the capacity rating of air conditioners is for total cooling, which includes latent cooling (moisture removal) as well as sensible. Most air conditioners have less capacity under dry coil tests when they are doing only sensible cooling (about 20-30% less), and this should be accounted for when comparing air conditioning to evaporative cooling by derating the air conditioner capacity and efficiency appropriately. The result being a comparison of sensible cooling for both systems.

- Evaporative Cooler Efficiency Ratio (ECER):

$$ECER = 1.08 \times CFM \times (Tdb_{room} - (T_{db,\,in} - \varepsilon \times (T_{db,\,in} - T_{wb,\,in}))) / W \qquad \text{(Equation 4)}$$

The California Title-20 ECER is a slightly modified version of Equation 3 that substitutes in the equation for effectiveness (Equation 1) solved for the supply air temperature. The effectiveness (ε), power (W), and airflow (CFM) are measured with an external static pressure of 0.3 inches of water column (IWC, or 75 Pa); and in accordance with the ASHRAE test standards, with a minimum entering wet-bulb depression of 25°F (14 K). The ECER is then calculated at standard rating temperatures of $Tdb_{,\,in}$ = 91°F, $T_{wb,\,in}$ = 69°F, and Tdb_{room} = 80°F. With these inputs, the equation simplifies to:

$$ECER = 11.88 \times (2\varepsilon - 1) \times CFM / W \qquad \text{(Equation 5)}$$

- Intake (or Outside) Air Capacity:

$$IA\ Capacity\ (Btu/hr) \approx 1.08 \times CFM \times (Tdb_{intake} - Tdb_{supply}) \qquad \text{(Equation 6)}$$

This alternative measure of capacity is defined in ASHRAE Standard 143 (Reference 5), which uses the same basic equation as Equation 3, but uses the intake dry-bulb temperature in place of an assumed room temperature. This is because an indirect evaporative cooler could use different air sources for the intake to the indirect cooling section and the intake to the evaporative section (although the Climate Wizard uses the same outside air source for both). When the intake air is the same as the outside air, this equation reduces to:

$$OA\ Capacity\ (Btu/hr) \approx 1.08 \times CFM \times \varepsilon \times WBD \qquad \text{(Equation 7)}$$

where WBD is the outside air wet-bulb depression (difference between the outside dry- and wet-bulb temperatures).

The capacity parameters listed in Equations 3, 6 and 7 are shown as approximations due to the nominal values of density and specific heat that produce the 1.08. For the reported results calculations, the calculations of capacity are made by determining the air mass flow rate and enthalpy from the measurements; except for the ECER values, which use Equation 5 directly.

EXPERIMENTAL DESIGN AND PROCEDURE

Test Facility

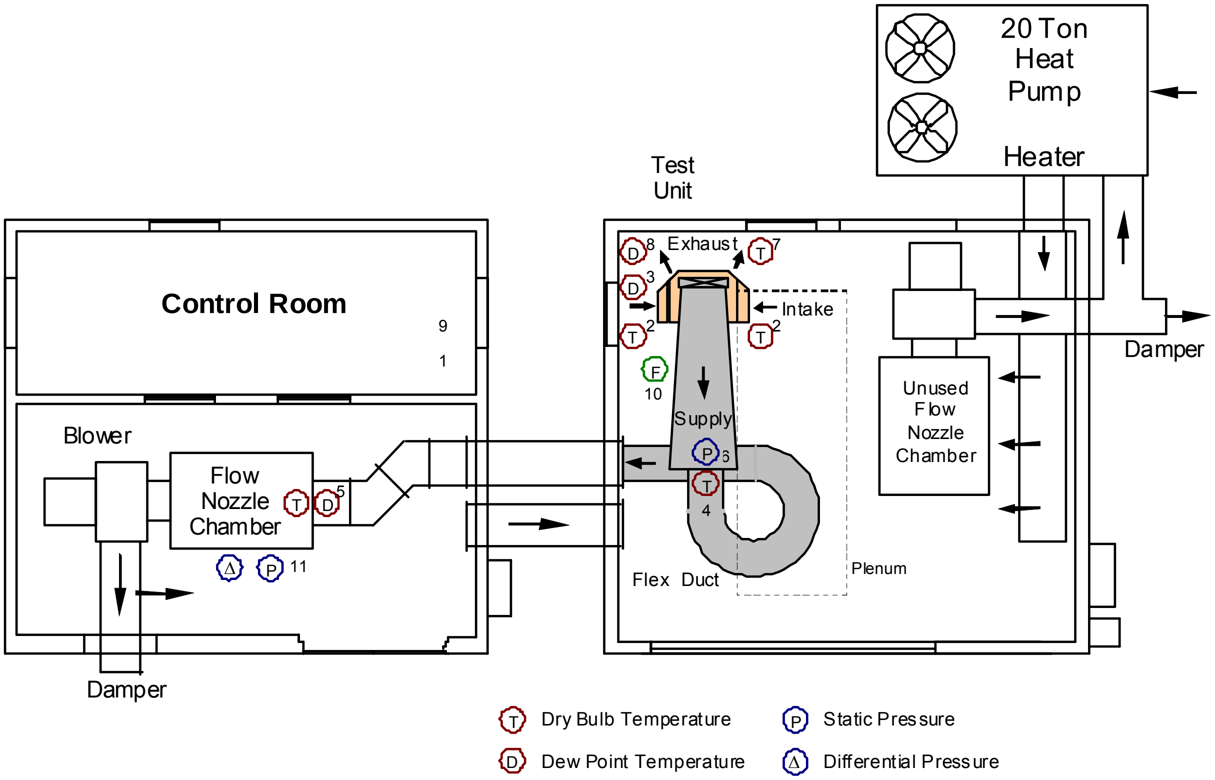
The test unit was placed in a controlled environment room to maintain the intake air conditions, and the supply air outlet was connected to an airflow measurement system located in an adjoining building. (A larger airflow measurement system located in the same room was not used because it did not have the lower range of the other.) The outlet from the rigid duct section provided with the test unit was connected to the passage to the adjacent space using a section of 2-foot diameter flexible duct. The airflow measurement system consists of a sealed chamber with several flow nozzles designed in accordance with ASHRAE specifications. A variable-speed blower on the outlet of the chamber was set to maintain the desired outlet static pressures and compensate for the added resistance of the flow measurement system and ductwork.

While the exhaust airflow was measured on some of the previously tested indirect systems, the long, dual opening prevented attaching a simple duct to capture the exhaust. Although the exhaust did discharge back into the room that the intake was drawing from, sufficient outside air was supplied to the room to displace the humidified exhaust air and maintain the desired conditions at the intake. For many of the tests, the entry door next to the unit was opened to allow the humid exhaust air a short path to escape the building. Circulation fans were also run in the controlled environment room to keep the air well mixed. A floor plan of the test facility showing the locations of equipment and instrumentation is shown in *Figure 3*.

To maintain the desired intake conditions to the test unit, temperature control in environmental chamber was achieved using the multiple stages of heat from the two-stage heat pump and variable output resistance heater (72 kW maximum). Testing normally had to be conducted when the outside temperature was less than that of the desired test condition, so only heating was required. Humidity control was achieved by modulating the fresh air economizer dampers on the heat pump to displace the humid air discharged by the exhaust (less fresh air was brought in for high-humidity tests). Dehumidification was inadequate from the heat pump in cooling mode and there was insufficient resistance heat to bring the air back up to temperature when attempted, so the low humidity tests had to be performed when the outside humidity ratio (or dew point) was less than the desired condition.

Figure 3: Test Facility and Measurement Locations

(The numbers correspond to the descriptions of the instruments in the next section)



Measurements and Instrumentation

The test set-up followed the guidelines described in the ASHRAE evaporator cooler test standards (References 1 and 2). Since the supply transition duct that is designed to pass into the attic between roof rafters was provided with the unit, it was decided to treat it as part of the package; thus, the supply air conditions (dry-bulb temperature and static pressure) were measured at the exit from this duct rather than at the supply outlet from the cooler. As the duct is uninsulated, there may be some small temperature gain from the room, particularly at low airflows.

The following is a listing of the measurements taken and the instruments used for the testing:

1. Barometric pressure using an electronic barometer.
2. Intake air dry-bulb temperature using four resistance temperature detectors (RTDs) on both right and left intakes (eight total).
3. Intake air dew-point temperature using a single chilled mirror sensor, with sample tubes drawing from both intakes.
4. Supply air dry-bulb temperature using four RTDs (located at the transition from the provided hard supply duct to the flex duct to create a mixing effect).
5. Supply air dew-point temperature using a chilled mirror sensor, taken at the nozzle chamber inlet.
6. Supply static pressure, using a low-range static pressure transmitter.

   Four taps were made at the end of the provided supply duct at the midpoint of each wall. The taps were connected together with a ring of tubing and tees, with an additional tee leading to the transmitter.

7. Exhaust air dry-bulb temperature, using eight RTDs: four strapped in front of each of the two exhaust openings.
8. Exhaust air dew-point temperature, using a chilled mirror sensor and a sampling tube array to each opening.
9. Total power, using a true-RMS power meter.
10. Make-up water flow rate, using a Coriolis mass flow meter.
11. Supply airflow rate, using a nozzle chamber and measurements of differential and inlet static pressure and inlet temperature.

All of the temperature instruments were calibrated simultaneously against a laboratory standard prior to the tests. The calibration included a low point using an ice bath (32°F / 0°C), and a high point using a hot block calibrator (~120°F / 49°C). The raw measurements were adjusted to match the reading from a secondary temperature standard RTD placed in the same bath. The transmitters for the differential and static pressure measurements were calibrated using a water manometer with a micrometer adjustment, accurate to 0.01 IWC (2.5 Pa).

Test Conditions

The test variables for this system included intake air temperature and humidity, supply outlet static pressure, and the speed setting for the variable speed fan. To limit the number of tests performed, the test program was split into two phases. For the first phase, the fan speed was held at its maximum and the intake conditions were varied, with tests done at two supply pressures: zero and 0.3 IWC (75 Pa). For the second phase, the intake air condition was held constant, while the fan speed and outlet pressure were varied. Some of the test results were used for both phases where the conditions overlapped.

For the first phase, the Climate Wizard was subjected to most of the same conditions that were used previously in the evaluation of other evaporative coolers. These conditions were developed by creating a matrix of dry- and wet-bulb temperatures that capture most of the climatic conditions in the PG&E service territory. *Table 2* lists the selected test matrix of eight intake air conditions:

Table 2: Test Point Matrix

(Shaded cells have less than the 25°F (14 K) wet-bulb depression required by ASHRAE test standards)

Dry-bulb	Wet-bulb Temperature		
Temp. °F	65°F	70°F	75°F
90	×	×*	×
100	×	×	×
110	■	×	×

* Test actually conducted at 91°F$_{db}$ / 69°F$_{wb}$ [ECER values]

In a typical residential installation, the system would be normally operated by means of a thermostat in the conditioned space. Since this did not apply in a laboratory setting, the thermostat control was used in manual mode to control the speed and operation of the water pump independent of temperature. Measurements were taken every 10 seconds, and the recorded test data were averaged over a stable period (usually about 30 minutes) and the averaged results were used to calculate the performance characteristics. The results from all of the tests were tabulated and analyzed graphically by plotting the results as a function of the control parameters.

RESULTS

The following section describes the testing results, along with a discussion of their impact. Most of the referenced graphs are located in the Appendix, along with summary tables of the individual test results.

The summary tables list the averaged values of the measurements and calculated performance parameters, and include the standard deviation of several key measurements over the duration of the test period.

System Operation

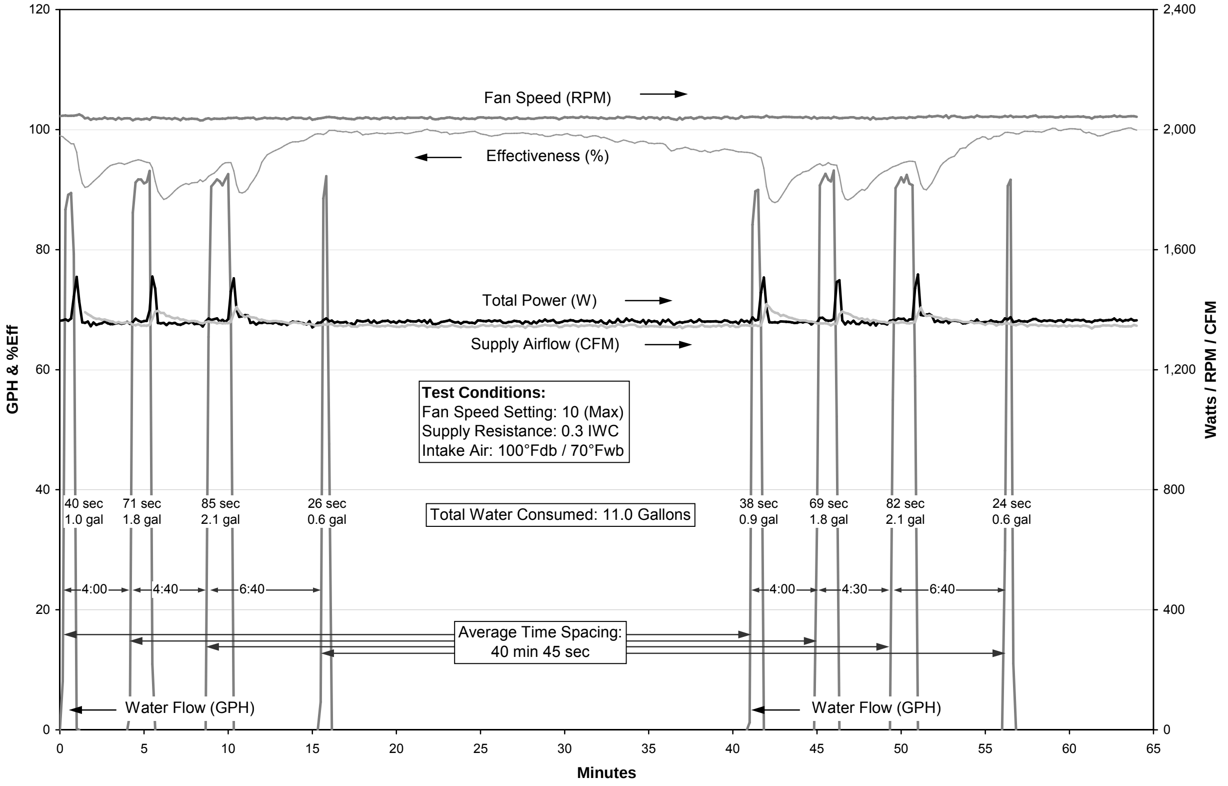
The design of the Climate Wizard offered a number of challenges in conducting the tests. The first issue was the size of the unit plus the supply duct that was provided with it, and how to get the system to fit in the environmental chamber. The test room has a large plenum suspended from the ceiling to capture airflow for measurement, such as from an air conditioner condenser. This plenum prevents anything tall being placed under it, so the supply duct from the Climate Wizard had to be placed along the side of this plenum. This forced the test unit to be placed in a corner of the room (as shown in Figure 3), with a less-than-optimal 1½-feet of clearance between it and the room walls. An air circulation fan was directed towards the corner from the back side of the unit in an attempt to provide a well-mixed supply of room air to the intake on that side, and also to push the exhaust air out from in front, while at the same time trying not to impact the flow of air in or out of the unit than what it would experience in calm air.

The duct sections that attached to the side of the unit and moved the intake to the top did not provide a complete seal when first installed. This may have been a defect caused in shipping, but there was an obvious gap along the edge next to the exhaust ports where the humid exhaust air could be drawn back through the intake. Although not part of the installation instructions, the gap was sealed with foil tape to prevent any recirculation. The installation instructions were also not clear as to where the remote thermostat plugged into the unit. After some exploration of the unit and a phone call to the supplier, the socket was found on a control board inside of a water-resistant box near the right side fan intake (as viewed from the front).

The operation of the water management system is not like that of most evaporative coolers and created another testing problem. In most systems, a pump operates continuously to keep the pads soaked in fresh water, and a bleed or flush pump is operated periodically to reduce the concentration of dissolved solids in the water reservoir. Apparently, the material applied to the wet side of the indirect evaporative cooler holds on to the moisture sufficiently long enough that the pump only needs to be operated intermittently to flush away solids and maintain the pad wetness. Without the constant flow of water, the water retained in the material can "wick" the heat absorbed from the walls by mass transfer to be evaporated easily into the air stream.

Figure 4 shows the trend of several measurements and parameters through the course of two wetting cycles with all of the other control parameters staying relatively constant. The cycle starts by opening the solenoid valve on the supply water to ensure that it is at the proper level for the pump. The flow rate of the water into the reservoir is high for an evaporative cooler at about 1½ GPM (or 90 GPH as graphed), and may actually have been restricted by the supply pipe. Once the level has been reached, the valve closes and the pump is activated for about 20 seconds, as indicated in the chart by a power spike of about 150W. As the water flushes out the wet side of the IEC, the exhaust airflow is temporarily restricted, resulting in a small rise in the supply airflow. From conversations with the manufacturer, there is supposed to be a reduction in fan speed to keep the airflow constant, but this was not observed as the fan speed remained steady. The basically ambient temperature water from the reservoir also drops the system effectiveness while the evaporation process on the exhaust path is impeded. This wetting cycle is repeated twice at intervals of about 4 and 4½ minutes, with the later make-up fills running longer than the first, probably because much of the first flush was absorbed by the relatively dry media. As shown in this sequence, there was often a fourth "top-off" fill that was not followed by the operation of the pump and thus had no effect on the system performance. The wetting cycles occurred consistently at an interval of almost 41 minutes, and this is reportedly a programmed system setting that is not affected by any of the external variables (temperature, humidity, airflow).

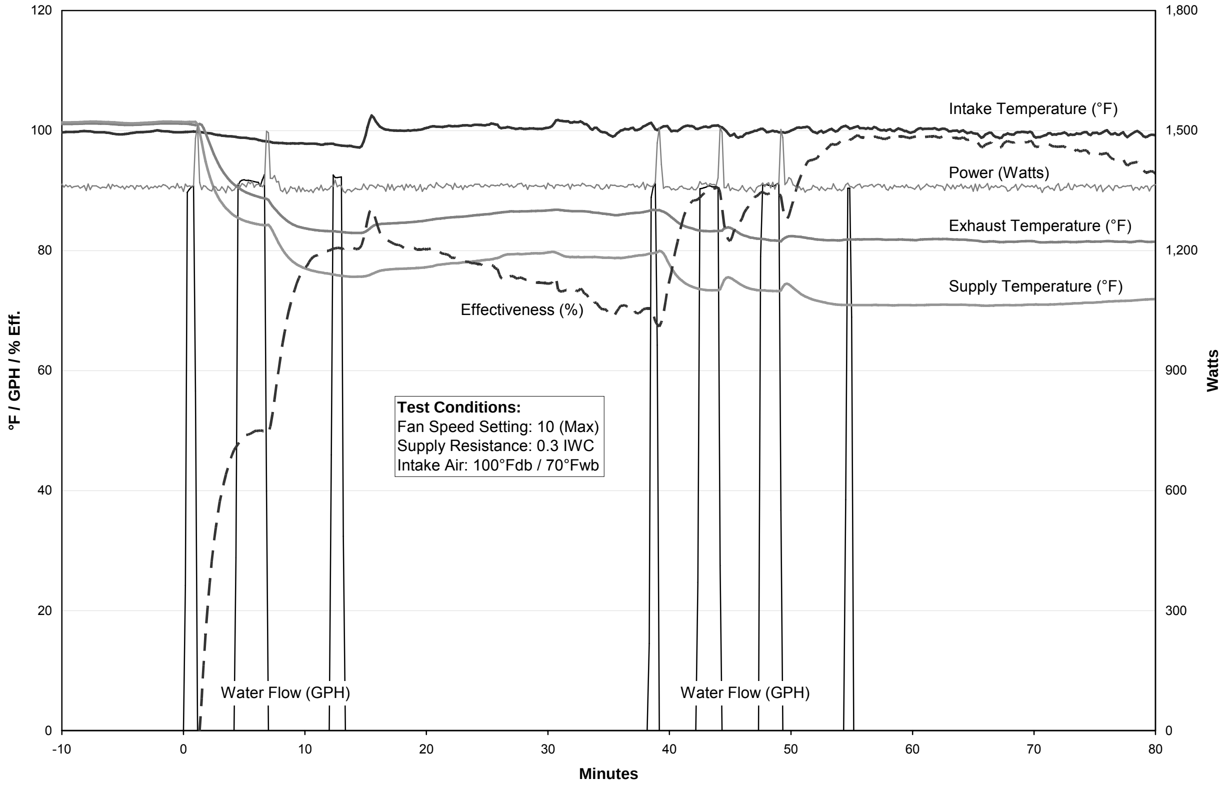
Figure 4: Operation of the Water Circulation System



The goal of the testing was to obtain and average the system performance over a period of steady-state operation in accordance with ASHRAE test standard rules. The activation of the wetting cycle creates a period of instability with reduced system performance. After recognizing that this pattern existed, the test procedure was adjusted to capture the relatively stable period of operation in between the wetting cycles, and also to make the changes in the external variables while one was in progress. The original plan coming from previous testing was to collect 30 minutes of data, but for this unit the averaging period had to be reduced to 25 minutes or less to capture this steady-state period. Not including the wetting cycle in the averaged data period does have the effect of discarding the reduced performance during that period, which would have an effect on the integrated overall performance of the system over time. However, this degradation is most apparent in the supply temperature, as the changes in power and airflow are too brief to have much influence. For example the average power over the entire period in the figure (including the pump operation spikes) is only 0.3% more than the average power from just the steady-state period. The slight rise in supply temperature during the wetting cycle would likely not be noticeable to most people.

Another concern with the system tests is that the size and mass of the IEC make the response time of the system slow in reaction to changes in system variables. This is most extreme when the system first goes into cooling mode and the indirect cooling media has not been fully wetted. *Figure 5* shows the trend of several performance measures following the switch from ventilation mode to cooling mode after causing the media to completely dry out (which took several hours at full fan speed and high supply resistance). The cooling effectiveness does not reach its maximum level until after the second wetting cycle, almost a full hour past the start of wetting the media.

Figure 5: Performance Trend after Cooling Mode Initiation



The desired optimal testing procedure was then to operate the system through two wetting cycles with the control variables constant, and then average the performance from the stable period between the second and the following wetting cycle before changing a variable. Due to time constraints on the testing, this could not always be accomplished and only a single cycle was run before changing the conditions. This was mainly done when the external variable change was quickly made and only affected airflow (fan speed and supply resistance), whereas the longer stabilization period was reserved for changes in intake air temperature and humidity. Another issue with the constraint on test time was that an initial "break-in" period of running the system continuously over several days was not performed. Plastic materials (like what make up most of the indirect module) tend to repel water at first and their wet-ability usually improves with time.

The control of the system went well throughout the testing, with only one operational problem. This occurred during two special test runs to see how the system performed under automatic thermostat control. The thermostat was placed in the room with the nozzle chamber and set to automatic cooling mode with a temperature setpoint of 74°F. As the temperature in the space cooled, the unit reduced the fan speed all the way down to its lowest setting; but after some time at this speed the fan motor shut off and the thermostat displayed Error Code 7. The error could be cleared by switching to manual and back to automatic, but it would not clear itself and restart. The manual did not have an explanation for this error code (just the more likely problems involved with restricted water supply). A phone call was placed to the manufacturer for an explanation, and the error was described as a software issue where during operation at the lowest fan speed the controller sometimes incorrectly diagnosed the feedback signals as a motor fault, so the power to the motor was cut to protect it. This was a problem that they were aware of and have updated the controller software to correct, but this test unit had apparently not received the update. New retail products should not have this problem, and it did not have any effect on the testing in manual mode.

Phase 1: Outlet Conditions at a Fixed Outlet Resistance and Variable Intake Conditions

Figure 6 shows a psychrometric chart with one set of test conditions and results. The control parameters applied were intake air properties of 100°F_{db} and 70°F_{wb}, maximum fan speed, and a supply resistance of 0.3 IWC (75 Pa). The resulting supply temperature was nearly 70°F_{db} (or a reduction of 30°F) for a wet-bulb effectiveness of 98%. The "indirect" effectiveness (using Equation 2) is 60%. The measurements of supply and intake dew point temperature were equal, indicating no moisture addition to the supply air. The exhaust air splits off from the supply with the same properties, and absorbs heat and moisture on its path through the wet side of the IEC module, resulting in an upward diagonal line to the right on the chart. The resulting exhaust temperature is about 81°F_{db}, or a rise of about one third of the temperature drop from the outside to the supply. The exhaust air is nearly saturated at 97% relative humidity, and the amount of moisture has more than doubled (a humidity ratio increase from 0.009 to 0.023 lb_w/lb_a).

The test procedure included obtaining these measurements at a variety of inlet conditions in accordance with the selected test matrix (Table 2). *Figure 7* shows the resulting supply air measurements from all of the tests in this group on another psychrometric chart. The tests were conducted at a supply outlet resistance of both zero and 0.3 IWC (75 Pa), which is used to provide data for the ECER calculation. (The tests done at zero resistance are indicated by circle symbols, and those at 0.3 IWC resistance are indicated by triangles, including the test shown in Figure 6.) The trends have been simplified slightly to just show the path of the intake air to the supply, and the exhaust air conditions are not shown. The resulting supply air temperatures were almost all at or below the reference room temperature used for the Title-20 ECER (shown as a vertical line), except for one extra test done outside the planned matrix with a very high dew point temperature. It should be noted that one set of conditions planned in the test point matrix (100°F_{db} / 65°F_{wb} - the point with the lowest humidity ratio) could not be reached because of the weather conditions at the time of the testing program and the inability of the testing laboratory to dehumidify.

Some of the trends shown show a small increase in humidity ratio, as if the system picked up some moisture through passing through the dry side of the IEC. However, this is most likely the result of a humidity measurement error at the intake resulting from the less-than-ideal setup in the laboratory, particularly the single air sampling points on the two intakes. The "real" path is likely a horizontal line at the supply humidity ratio between the two measured temperatures.

Included in this figure is a Climate Wizard Performance Line provided by Seeley for an earlier version of the product. This performance curve was not provided with any reference frame, so it is not known if it is dependent on fan speed or supply resistance. What it represents is the expected supply temperature from any point to the right of the line. This suggests that the supply temperature is only a function of the humidity ratio (or dew point temperature), and that the intake dry-bulb temperature does not matter. While the test results did not quite approach this line, there is some evidence to support this. For example using two tests done at 0.3 IWC resistance, at an intake condition of 100°F_{db} and 75°F_{wb}, the humidity ratio averaged 0.0134 lbw/lba (65°F_{dp}) and the resulting outlet temperature was 75°F_{db}. An extra test done at about the same humidity level (0.0128 lb_w/lb_a, 64°F_{dp}) but with a dry bulb temperature 20°F higher, resulted in a supply temperature only 3°F higher. It is also interesting to compare Figure 7 with Figure 6, and how this performance curve has a similar slope to the path of the exhaust air.

Reference 5 offers a simple linear equation for calculating the supply air temperature as a function of intake dry-bulb and dew-point temperatures, which is assumed to be for a specific speed and supply resistance. A linear regression of the test results provides the following coefficients to the equation, along with the correlation coefficient:

$$T_{db,\ supply} = a + b \times T_{db,\ intake} + c \times T_{dp,\ intake} \qquad \text{(From Reference 5)}$$

Supply Resistance (IWC)	a	b	c	r^2
0.0	17.96	0.325	0.411	0.991
0.3	27.59	0.219	0.387	0.955

The correlation is particularly close for the zero resistance case, and the supply temperature calculated using the equation is always within 0.5°F of the actual measurement. However, this equation does not support the Climate Wizard Performance Curve shown in Figure 7, since the dry bulb temperature of the intake air does actually matter. The supply air temperatures calculated from these equations have also been added to the Figure (indicated by smaller open symbols).

Table 3 contains three different measures from these tests as a function of the inlet dry and wet-bulb temperatures as laid out in Table 2: the resulting supply and indirect stage exhaust temperatures, and wet-bulb effectiveness. (The points that do not have the 25°F wet-bulb depression required by the ASHRAE Standards are shaded.) The first pair of tables that show the supply air temperatures are the same results as shown graphically in Figure 7.

Table 3: Performance Measures at Full Fan Speed

(* Test done at 91°F_{db} / 69°F_{wb})

Supply Temperature (°F)

0.0 IWC Supply Resistance

Dry-bulb	Wet-bulb Temperature		
Temp. °F	65°F	70°F	75°F
90	69	71*	76
100	N/A	73	77
110		73	78

0.3 IWC Supply Resistance

Dry-bulb	Wet-bulb Temperature		
Temp. °F	65°F	70°F	75°F
90	67	70*	74
100	N/A	71	75
110		70	75

IEC Exhaust Temperature (°F)

0.0 IWC Supply Resistance

Dry-bulb	Wet-bulb Temperature		
Temp. °F	65°F	70°F	75°F
90	79	81*	82
100	N/A	84	87
110		88	90

0.3 IWC Supply Resistance

Dry-bulb	Wet-bulb Temperature		
Temp. °F	65°F	70°F	75°F
90	77	79*	81
100	N/A	82	85
110		84	88

Wet-Bulb Effectiveness (%)

0.0 IWC Supply Resistance

Dry-bulb	Wet-bulb Temperature		
Temp. °F	65°F	70°F	75°F
90	87	92*	96
100	N/A	91	92
110		92	91

0.3 IWC Supply Resistance

Dry-bulb	Wet-bulb Temperature		
Temp. °F	65°F	70°F	75°F
90	97	98*	103
100	N/A	98	99
110		99	101

Figure 8 and *Figure 9* show one method of describing the cooling capacity and efficiency of an evaporative cooler. In this case, the capacity calculation is by Equation 6, and describes how much the intake air has been cooled (rather than the ability to cool a space based on using a reference room temperature like for the ECER and AS 2913). The second chart of energy efficiency ratio (EER) is basically the capacity from the first divided by the total unit power; however, since the power usage was relatively constant for these tests, the charts are virtually identical. The results show a very close relation

as a function of the intake air wet-bulb depression, which implies that the hotter and drier the intake air, the greater the system's capacity to cool it. As an indirect system, these results might be better represented as a function of the intake dew-point temperature depression rather than wet-bulb, but the correlation was not quite as close and this basis enables Figure 8 to be compared with the previous test reports that had similar charts. An important point to consider is that this system shows true sensible cooling that is not offset by unwanted latent heat gain as in direct systems. As indicated in Equation 7, the intake air capacity may be described a function of the product of the air flow rate and the wet-bulb effectiveness. In comparing the results with and without supply resistance, the results show that while the higher resistance lowered the supply temperature and thus improved the effectiveness, the corresponding reduction in airflow was of a larger magnitude, resulting in a lower cooling capacity.

Phase 2: Fixed Inlet Conditions, Variable Outlet Resistance

For the next set of tests, the intake conditions were maintained constant while the supply outlet resistance was varied. The outlet resistance was varied by changing the speed of the booster fan on the nozzle chamber to maintain the required value. The intake condition selected was 100°F_{db} / 70°F_{wb}, which is close to the Australian rating condition and meets the ASHRAE requirement of a minimum 25°F wet-bulb depression. (Detailed results from these tests may be found in the test summary tables at the end of the Appendix.)

The results of these tests are shown as a series of five charts in the Appendix plotted as a function of supply airflow, since this is the recommended reporting method from the ASHRAE Standards. *Figure 10* shows the trend of supply outlet resistance as a function of supply airflow. This chart is conceptually reversed, since the supply resistance and fan speed are the applied variables and the airflow is the effect. The results show that the supply airflow varies linearly with the applied external resistance for each of the speeds tested, and the equations derived from a linear-regression curve fit are provided. While only six of the ten speed settings were evaluated with supply resistance, all ten were checked at zero resistance.

In addition to these trends are some dashed curves intended to track the system performance through the later figures. One curve is the trend with a constant 0.3 IWC supply resistance applied to all of the speeds. Since the Title-20 ECER uses this resistance for calculating the rating, this trend will show how the system would rate at each speed. However, for any duct system as the airflow is reduced, friction decreases resulting in a lower outlet resistance. The other dashed curves on the chart represent the typical system curves, where supply pressure is a function of the square of the airflow rate. The curves are drawn based on a particular static pressure at full fan speed. In addition to a curve derived from 0.3 IWC (75 Pa) at full speed, are curves based on 0.15, 0.50, and 0.75 IWC (37, 125, and 187 Pa). With this graphing arrangement, these curves are drawn as the right half of a parabola.

Figure 11 shows the trends of fan speed in RPM. All of the curves drawn for a particular speed setting show a small rise as the supply pressure is increased. This implies that the total intake airflow is reduced slightly as the supply resistance is increased, although this effect is small because raising the supply resistance mainly just diverts more air through the exhaust path. Since all of the speeds were checked at zero resistance, it is possible to derive an equation to give an approximation of the fan speed for each setting. As shown in the chart, the fan speed is approximately 946 RPM multiplied by the speed setting (1 through 10) raised to the power of 0.347.

One of the most important of these figures is *Figure 12*, which shows the trend of power consumption. All of the system curves (including the one with a constant zero resistance) are based on the relation shown in Figure 10, where supply pressure is a function of the airflow rate squared. Since fan power is related to the product of airflow rate and static pressure rise, the power is approximately a function of the cube of the airflow rate, and the system curves reflect this. For a given speed setting, the power consumption is not particularly influenced by the applied supply pressure, just like for the fan speed. Also like speed, an equation can be formulated to approximate the power as a function of the speed setting, and this equation is included in the chart.

Reference 4 presented test data from an early prototype of the Climate Wizard, which was then called the DriCool. The date were not complete in that they did not completely state the conditions of the test (fan speed and supply resistance were not given), but there are a few results with enough information that they can be used for comparison. The three test results from that report giving power as a function of airflow have been added to this figure. In comparison with the tested Climate Wizard, the performance measures of the DriCool fall between fan speed settings 7 and 8, with a supply resistance ranging between 0.5 and 0.75 IWC. Like this Climate Wizard, the power consumption of the DriCool was not significantly influenced by the supply resistance.

Figure 14 shows the trend for wet-bulb effectiveness, which presents one of the more confusing results from these tests. At the higher fan speed settings (6 through 10), the effectiveness values mostly fell into a fairly consistent relationship as a function of airflow, with increasing values as the airflow decreased. The individual control factors of supply resistance and fan speed did not matter much so long as they combined to produce the same airflow. A curve has been drawn through this "main sequence", and extrapolated to lower flow rates (indicated with a dashed curve). At lower fan speed settings however, the results deviated from this main sequence, with the results having lower values for a particular airflow rate. The main reason for this is that to produce the same supply airflow rate as for the higher speeds, less supply resistance is required; which means a larger fraction of the total intake airflow will be going to the supply and less to the exhaust stream that does the actual cooling. One of the compromises for this testing program was to only measure the supply airflow, and this figure would be more informative if it could be grouped according to the fraction of total intake airflow that is going to the supply or exhaust. *Figure 15* provides another interpretation of the effectiveness, this time graphed as a function of the supply resistance control variable. The trend shown for the maximum speed setting (Speed 10) shows a consistent increase with rising resistance. The chart also shows higher numbers for the same resistance but lower fan speed, which again means a larger portion of the intake airflow going out the exhaust.

Figure 14 and Figure 15 are drawn with a lower limit starting at 90%, which is already greater than what most direct evaporative coolers can achieve. For the main sequence results in Figure 14, the wet-bulb effectiveness exceeded 100% for supply airflow rates below 1,265 CFM, or about 23% less than the maximum airflow. The measured test results peaked at an effectiveness of 112%, which is very impressive for a completely indirect system. The earlier results from the horizontal DriCool unit were higher, peaking at 126%; but again the complete conditions of those tests are not known, nor are the modifications that have been made to create this production model.

Figure 13 shows the trend of ECER as calculated by Equation 5. The value of the ECER is dominated by the CFM / Watt relation, the inverse of which was displayed graphically in Figure 12. The actual value of ECER that is used for the rating is for full airflow at 0.3 IWC supply resistance, which in these results works out to be about 12.4. Following the curve with a constant 0.3 IWC resistance, reducing the fan speed results in increasingly higher values of ECER, peaking at about 23 Btu/Wh at Speed 2. (At Speed 1, the 0.3 IWC resistance could not be achieved with any airflow.) Alternatively, if the system curve is followed, the system reaches a maximum ECER of about 43 at Speed Setting 1. This graph demonstrates that the Title-20 ECER rating may not be an ideal indicator of performance, and what is probably needed for variable flow systems like this is some method of seasonally averaging the efficiency to take advantage of the improved efficiency at part-load operation.

Figure 16 shows an estimate of the system water consumption as a function of airflow rate and intake wet-bulb depression. These values are only an approximation and are widely scattered because of the intermittent water supply to the unit. The values shown in the chart are derived from long duration data collection files that contained several individual tests. These files were usually the obtained while the intake conditions were held constant while one step in the supply resistance or fan speed was changed during one of the pad wetting cycles. (Data were logged constantly while the changes were made.) The indicated airflow rate is an average for the entire data record period, as is the totalized water consumption. As an example of a shorter-term analysis, Figure 4 showed an example where about 5½ gallons were consumed every 41 minutes (which is an average of 8.1 GPH) at a constant airflow rate of 1,350 CFM and a wet-bulb depression of 25°F, and this is consistent with the longer duration results with variable airflow.

Table 4 provides a summary of some key performance measures for comparison with the results from the previous testing of other evaporative coolers. Note that all of the products listed in this table were early production models, and may have since undergone modification. All of these products are still commercially available.

Table 4: Comparison Averaged Test Results at Maximum Fan Speed

Zero supply resistance

Test Unit	Breezair Icon (Direct)	OASys (Indirect / Direct)	Coolerado (Indirect)	**Climate Wizard** **(Indirect)**
Supply Airflow cfm [liters/s]	4,370 [2,060]	1,330 [630]	1,440 [680]	**1,610** **[760]**
Total Unit Power kW	1.19	0.58	1.32	**1.35**
Wet-bulb Effectiveness [1]	83%	104%	89%	**91%**
“Indirect” Effectiveness [1]	0%	21%	53%	**53%**

Sensible capacity measures with ~100°F$_{db}$/70°F$_{wb}$ [38°C$_{db}$/21°C$_{wb}$] intake air and zero supply resistance

Supply Air Temperature °F [°C]	75 [24]	69 [21]	72 [22]	**73** **[23]**
Room Capacity [2] tons [kW]	1.88 [6.6]	1.28 [4.6]	0.96 [3.4]	**1.05** **[3.7]**
Room EER [2] Btu/Wh [COP]	18.9 [5.5]	26.4 [7.7]	9.0 [2.6]	**9.3** **[2.7]**
Intake Air Capacity [3] tons [kW]	9.59 [33.7]	3.52 [12.4]	3.42 [12.0]	**3.88** **[13.6]**
Intake Air EER [3] Btu/Wh [COP]	96.4 [28.3]	72.5 [21.2]	32.3 [9.5]	**34.4** **[10.1]**
Water Consumption GPH [liters/hr]	13 [51]	5 [4] [21]	12 [45]	**11** **[42]**
Humidity Ratio Increase (%)	64%	52%	0%	**0%**

At 0.3 IWC [75 Pa] supply resistance

Supply Airflow cfm [liters/s]	3,890 [1,840]	975 [460]	1,270 [600]	**1,350** **[640]**
Total Unit Power kW	1.15	0.57	1.27	**1.37**
Wet-bulb Effectiveness [1]	83%	108%	94%	**100%**
“Indirect” Effectiveness [1]	0%	26%	59%	**61%**
CA Title-20 ECER Btu/Wh	27.8	23.1	10.1	**12.4**

Sensible capacity measures with ~100°F_{db}/70°F_{wb} [38°C_{db}/21°C_{wb}] intake air and 0.3 IWC [75 Pa] supply resistance

Supply Air Temperature	°F [°C]	75 [24]	67 [19]	72 [22]	**71 [21]**
Room Capacity [2]	tons [kW]	1.70 [6.0]	0.88 [3.1]	0.90 [3.2]	**1.11 [3.9]**
Room EER [2] [COP]	Btu/Wh	18.0 [5.3]	18.2 [5.3]	8.5 [2.5]	**9.8 [2.9]**
Intake Air Capacity [3]	tons [kW]	8.54 [30.0]	2.24 [7.9]	3.05 [10.7]	**3.47 [12.2]**
Intake Air EER [3] [COP]	Btu/Wh	90.2 [26.4]	46.2 [13.6]	28.9 [8.5]	**30.6 [9.0]**
Water Consumption	GPH [liters/hr]	12 [45]	5 [4] [20]	10 [38]	**8 [30]**
Humidity Ratio Increase (%)		65%	49%	0%	**0%**

[1] Average with a wet-bulb depression of at least 25°F (14 K)

[2] Room Capacity ≈ 1.08 × CFM × (80°F – T_{supply})/12,000
AS 2913 results will be greater, since its reference temperature is 81.3°F

[3] Intake Air Capacity ≈ 1.08 × CFM × (T_{intake} – T_{supply})/12,000

[4] Water maintenance/bleed system disabled during test

CONCLUSIONS

This study investigated the performance of an introductory model of the Climate Wizard indirect evaporative cooler. The primary advantages of the Climate Wizard in relation to other evaporative coolers are the ability to provide cool air to a space without moisture addition and its variable speed fan motor technology that allows it to provide reduced airflow for significantly less power. As this evaluation was only a series of short-term tests, they give no indication of its long-term reliability or maintenance requirements in actual use.

Some of the key findings are summarized below.

1. With a selection of six out of a possible ten fan speeds plus various combinations of supply outlet resistance and intake dry- and wet-bulb temperatures, there were a significant number of tests performed on this system. Because of a short time window to complete the tests, some were not run as long as they should have been in order to reach steady-state conditions, particularly for cases with low airflow rates. The sheer size of the indirect evaporative cooling media in this system (which is needed to achieve high effectiveness results) contributed to a slow response time to system changes. Thus, some of the test results are questionable.
2. The wet-bulb effectiveness varied from 89% to 112% over the range of test conditions. The effectiveness was mainly sensitive to the airflow, with increasing numbers as the airflow is decreased. The introduced "indirect" effectiveness (measuring how much the wet-bulb temperature was reduced towards the dew point) ranged from 39% to 78%.
3. Supply air temperatures ranged between 66 and 81°F over the range of test conditions. This means that it usually provided some cooling effect compared to a reference room temperature of 80°F. The highest supply temperature occurred at the unusually high humidity condition of 100°F_{db} and 80°F_{wb} (not part of the usual test point matrix), and the intake air was still cooled by 19°F. The dry-bulb temperature reduction from the intake air ranged from 15 to 43°F. There is also no change in the moisture content of the air from the intake.

4. The maximum supply airflow at high speed and zero resistance was about 1,610 cfm, or about the same as for a 4-ton compression-based air conditioner. This would make the system easy to connect to existing ductwork in a residence if it was sized appropriately.
5. The power consumption of this system at zero supply resistance averaged:
    - 1,350W at high speed (Speed 10),
    - 990W at medium speed (6), and
    - 166W at the lowest speed (1).

    At its highest speed, the system still only used about 40% of the power of a 3-ton air conditioner.
6. The California Title 20 evaporative cooler efficiency ratio (ECER) does not reflect increased comfort from the reduced moisture addition to the supply air, and thus treats this and other systems with indirect components poorly when compared to direct systems. The ECER for this system was calculated at 12.4 Btu/Wh at high speed. Lower speed settings provided higher values, peaking at 23.0 at Speed 2 with the required 0.3 IWC.

Recommendations for Follow-on Activities

To compare the performance of the Climate Wizard and other evaporative cooling technologies against competitive compression-based air conditioners, a combination of laboratory, computer modeling and field monitoring data must be collected and analyzed. These laboratory results may be used to develop a computer model to evaluate how much of a cooling season this system would be able to keep a house comfortable in different climates, and for what cost in energy and water use. This model should be calibrated using field data to estimate more accurately the annual cost to operate.

The ECER currently calls for a fixed external resistance. However, in a variable speed system like this one, the outlet resistance would decrease with approximately the square of the airflow, and thus follow the system curve shown in Figure 13 for a resistance at 0.3 IWC at the highest speed. This results in very high values of ECER at low speeds. Perhaps a refinement of the ECER is required for variable or multiple speed systems like this one to account for the times that the system will operate at lower fan speeds than the maximum, which will likely be most of the time. An evaporative cooler correctly sized to the building heat load is only required to run at full speed under the design climatic conditions. These conditions only occur for a small proportion of the cooling season. For the rest of the season, adequate cooling to meet comfort requirements is provided at less than full fan speed. Additional system modeling or testing could be done with the goal of determining a seasonal ECER (integrating the total cooling provided divided by the total power consumed over a summer cooling season), and a set of tests that could be developed to predict this result and create a better system rating (similar to the SEER rating for small air conditioners).

ECER is designed primarily to rate direct evaporative coolers, and could be enhanced to account for the added comfort provided by an indirect evaporative cooler. Indirect systems are currently penalized in the current rating because of the power required to push air through the secondary air path that is exhausted rather than delivered to the space. As compared to a direct evaporative cooler that can produce the same outlet temperature (equal effectiveness), an indirect system provides relatively lower humidity air. The ECER should give an energy credit for this “virtual” dehumidification.

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APPENDIX

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Figure 6: Process Description at One Test Condition

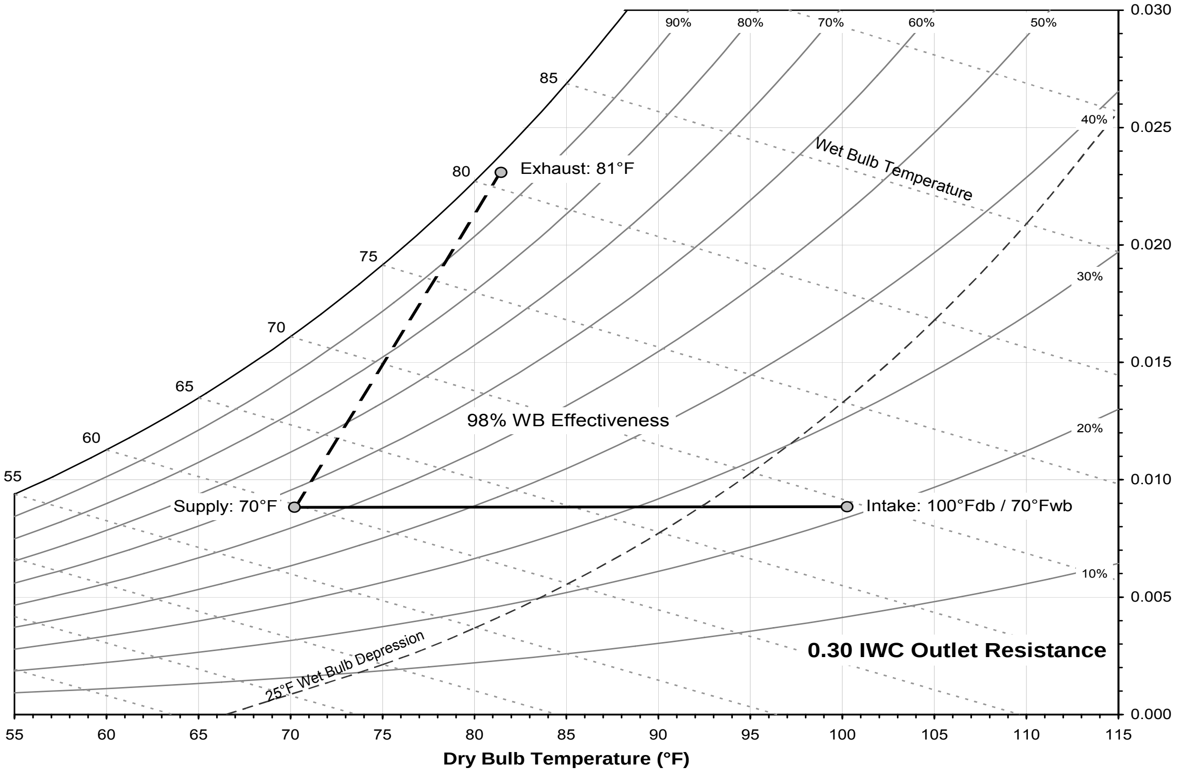

Figure 7: Performance at All Variable Intake Conditions

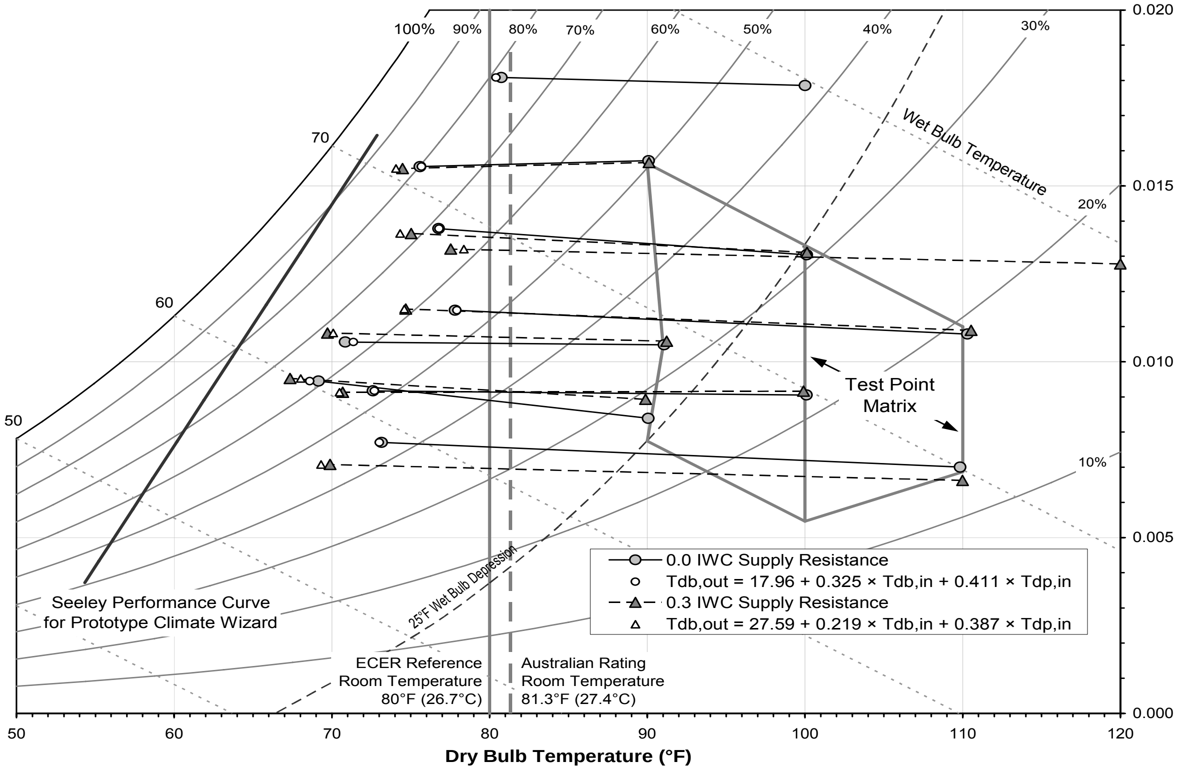

Figure 8: Intake Air Cooling Capacity versus Wet Bulb Depression

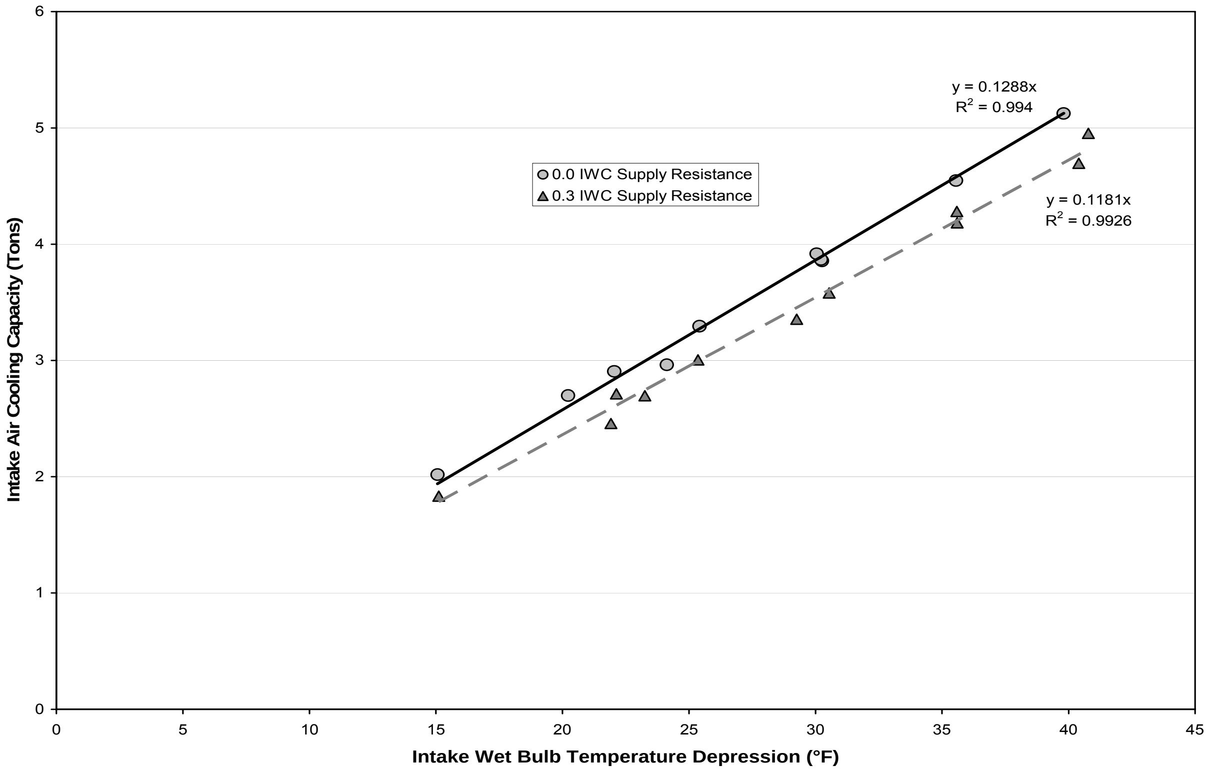

Figure 9: Intake Air Cooling EER versus Wet Bulb Depression

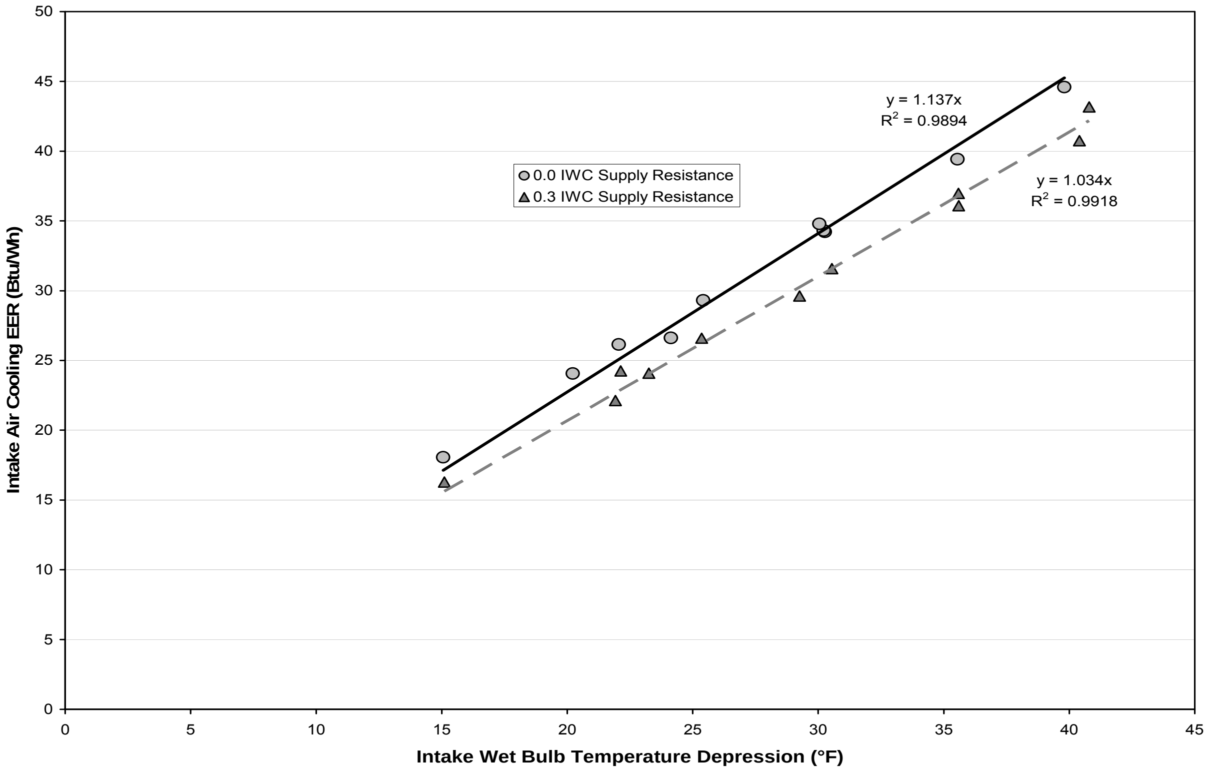

Figure 10: Outlet Resistance versus Supply Airflow

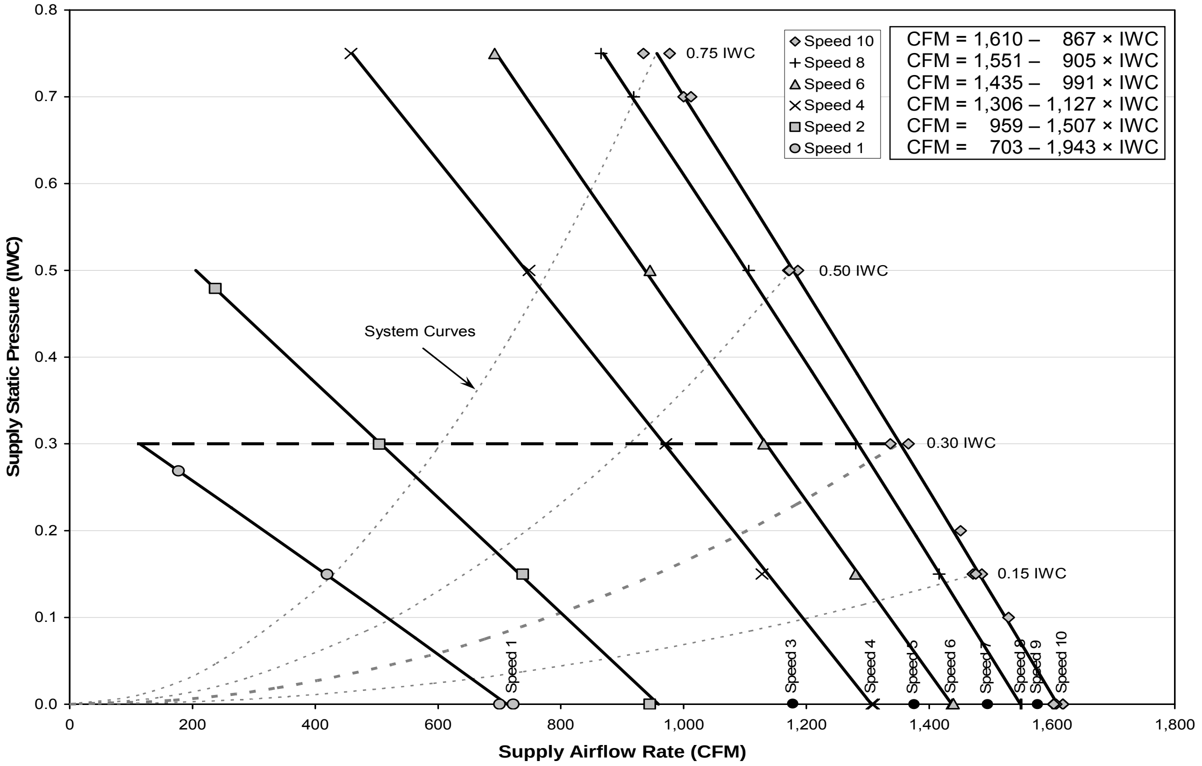

Figure 11: Fan Speed versus Supply Airflow

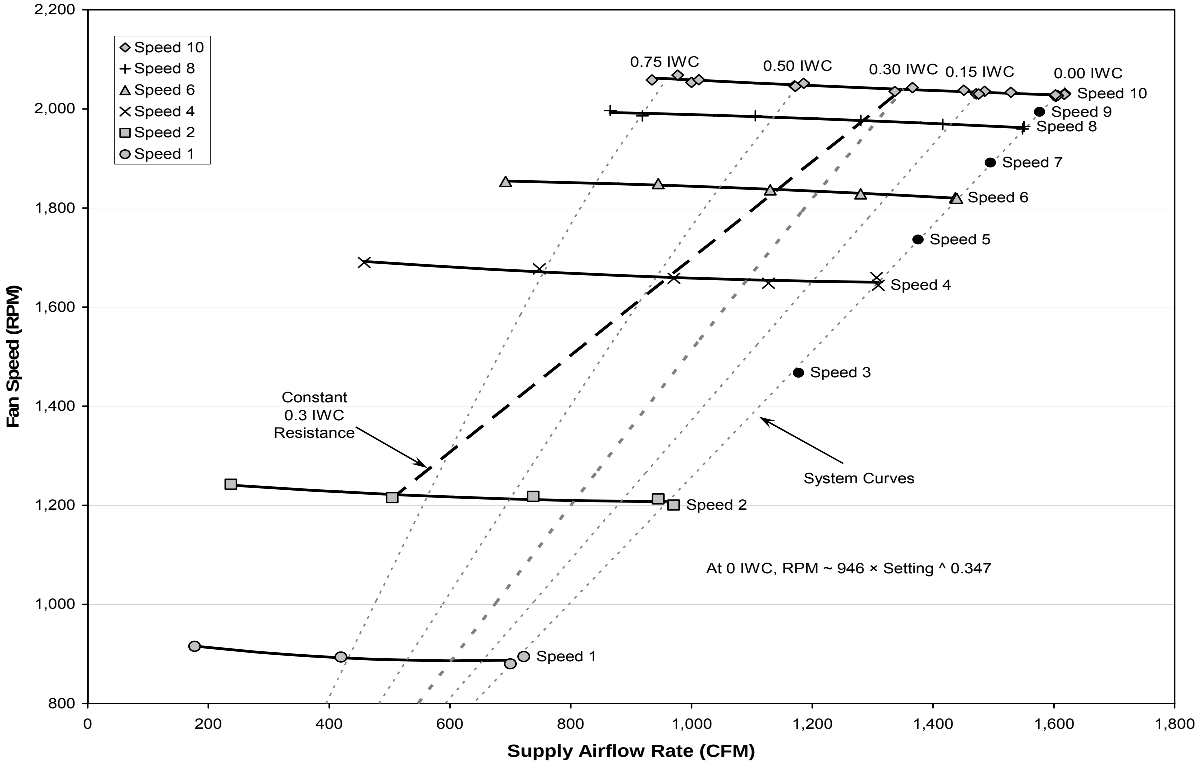

Figure 12: Power Consumption versus Supply Airflow

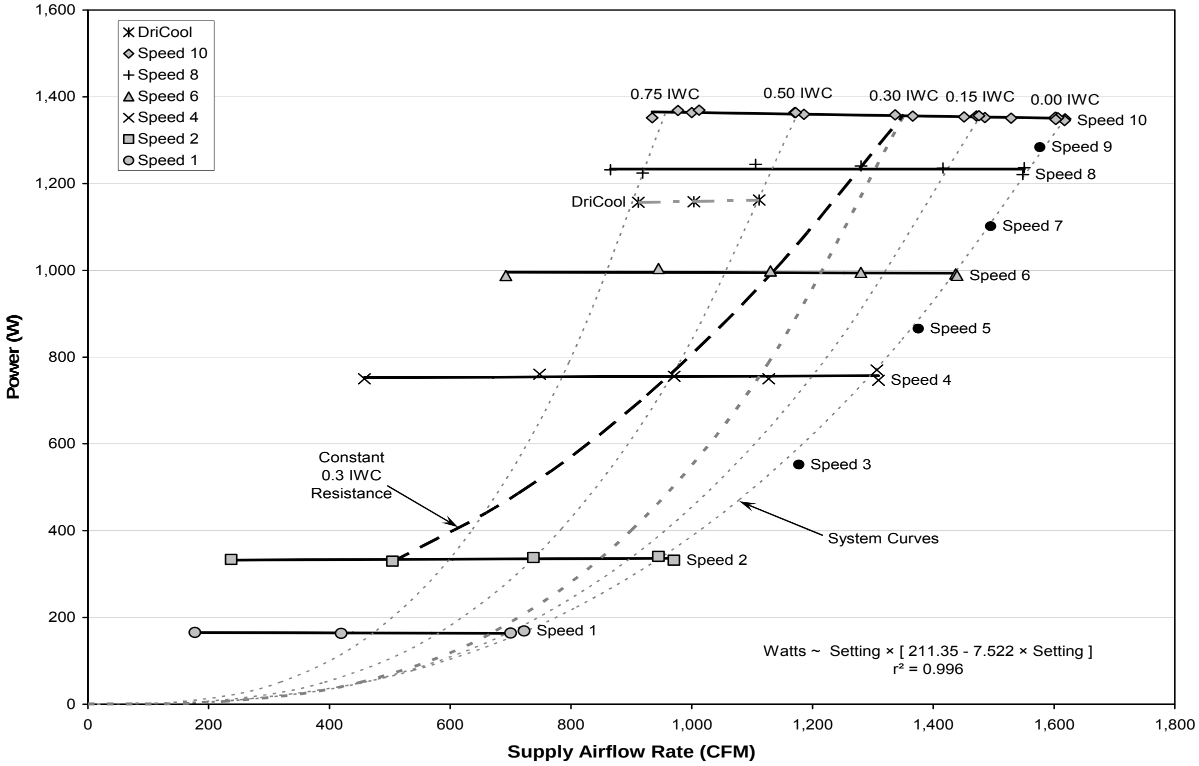

Figure 13: ECER versus Supply Airflow

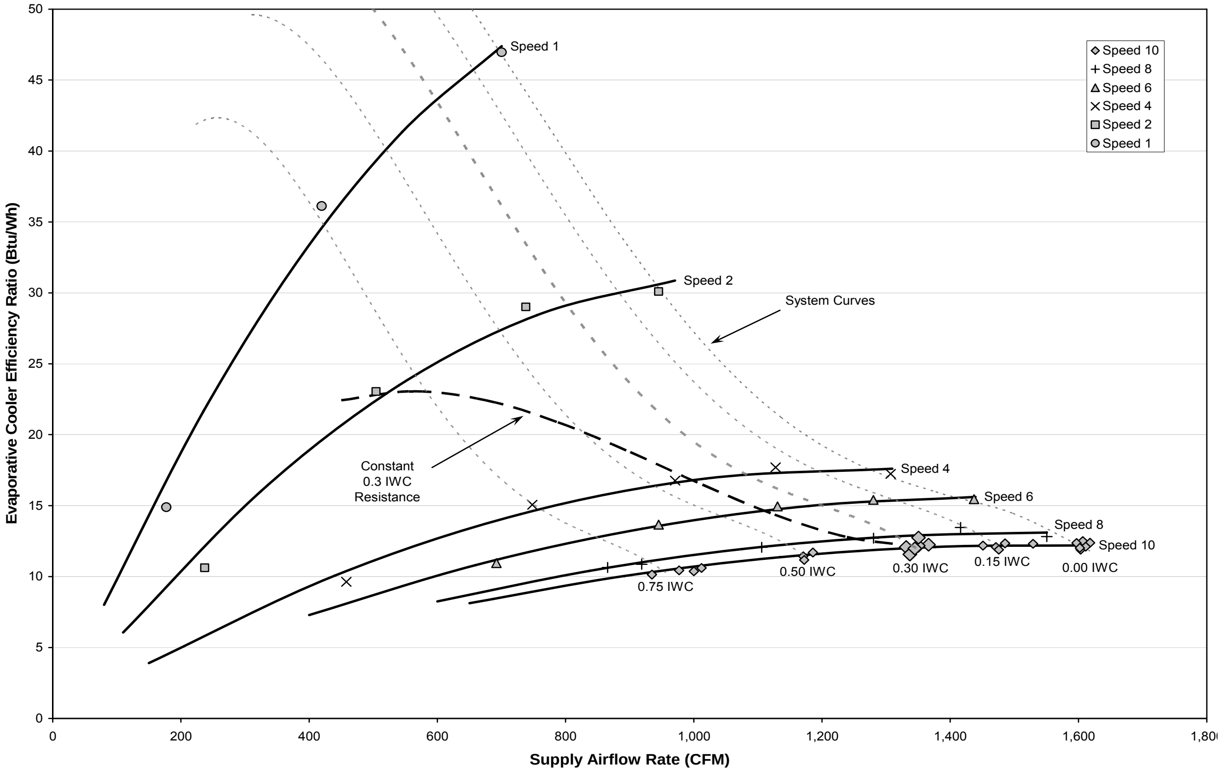

Figure 14: Effectiveness versus Supply Airflow

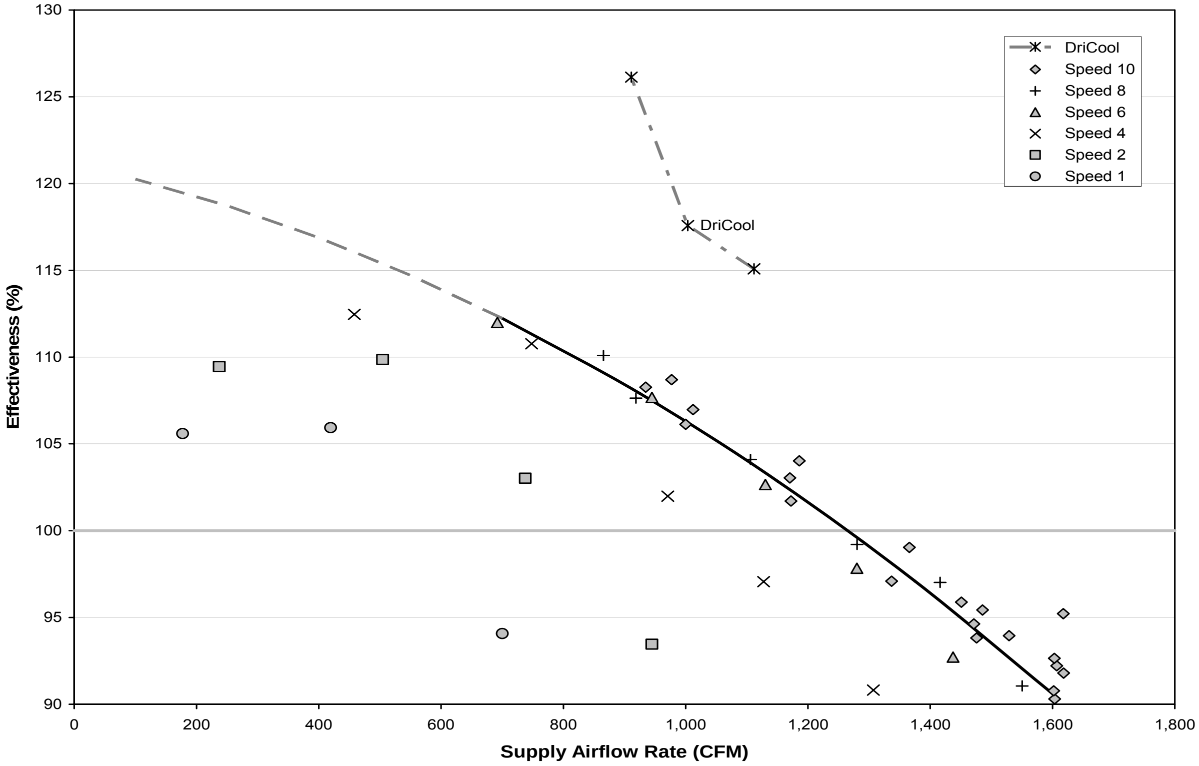

Figure 15: Effectiveness versus Supply Resistance

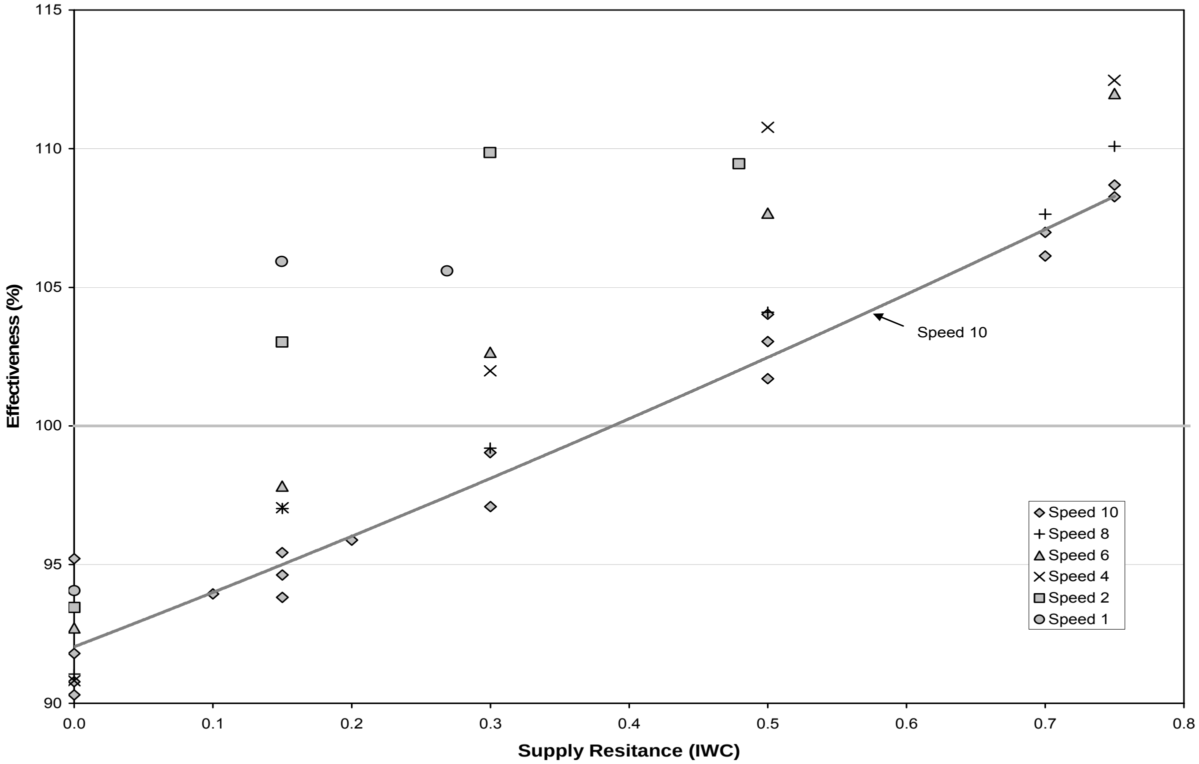

Figure 16: Water Consumption versus Supply Airflow

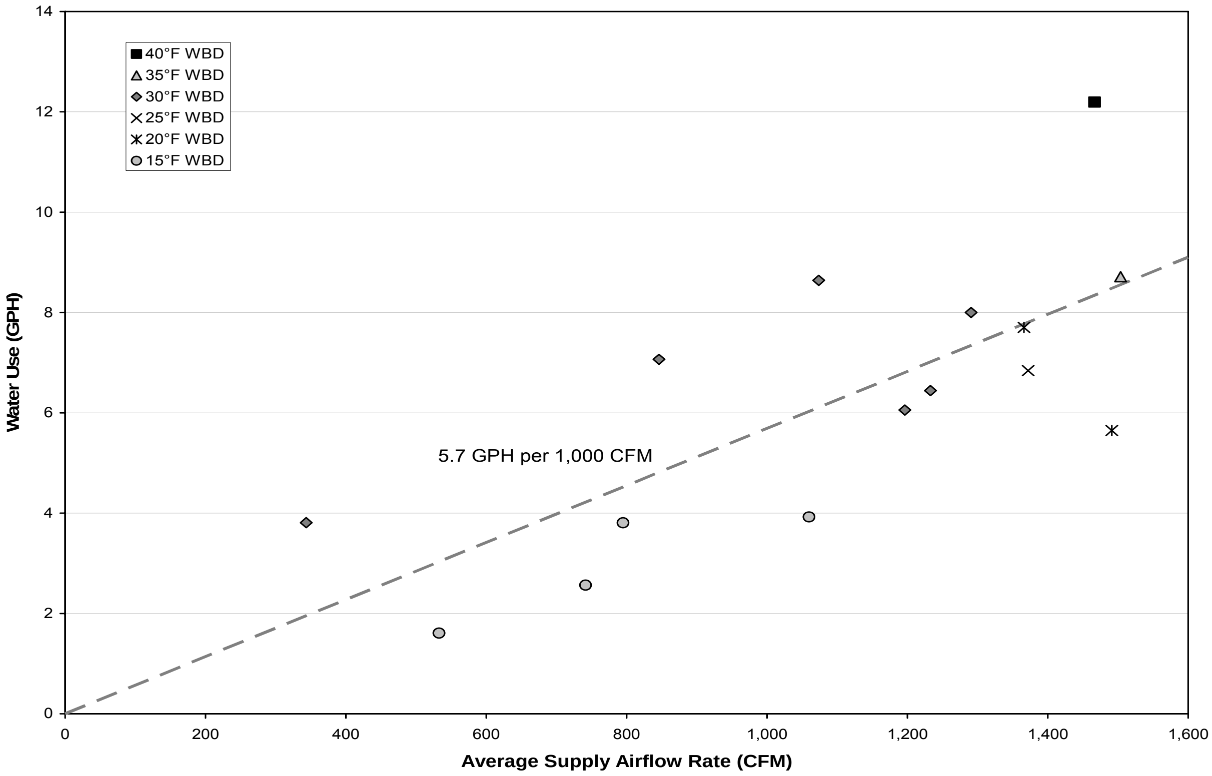

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Table 5: Climate Wizard Test Data

Test Summary Information	Tests at Maximum Fan Speed and Zero Resistance									
General [Average (Std. Dev)]										
Date (2009)	8-Jul	29-Jun	30-Jun	25-Jun	26-Jun	26-Jun	18-Jun	24-Jun	29-Jun	29-Jun
Start Time	1:40p	11:09a	11:58a	4:10p	1:40p	2:03p	2:58p	5:26p	4:27p	3:11p
Duration (minutes)	25	20	30	20	9	15	15	12	15	20
Barometric Pressure (in. of Hg)	29.38	29.33	29.29	29.41	29.43	29.43	29.36	29.30	29.27	29.28
Inlet Air Properties										
Dry Bulb Temperature (°F)	90.1 (0.3)	91.1 (0.3)	90.1 (0.1)	99.9 (1.9)	100.3 (0.9)	100.1 (0.5)	100.1 (0.2)	100.0 (0.1)	109.8 (0.5)	110.3 (0.4)
Dew Point Temperature (°F)	51.9 (0.3)	57.9 (0.4)	69.2 (0.2)	53.5 (0.2)	54.2 (0.2)	54.3 (0.2)	64.0 (0.3)	72.8 (0.2)	47.0 (1.2)	58.6 (0.7)
Wet Bulb Temperature (°F)	65.9 (0.1)	69.0 (0.2)	75.0 (0.1)	69.6 (0.6)	70.1 (0.3)	70.1 (0.2)	74.7 (0.2)	79.8 (0.1)	70.0 (0.5)	74.8 (0.4)
Wet Bulb Depression (°F)	24.1	22.1	15.1	30.3	30.2	30.0	25.4	20.2	39.8	35.6
Relative Humidity (%)	27.3	32.9	50.4	21.4	21.7	21.9	30.9	42.1	12.5	19.0
Supply Air Properties										
Dry Bulb Temperature (°F)	69.2 (0.1)	70.8 (0.2)	75.6 (0.1)	72.6 (0.3)	72.9 (0.4)	72.4 (0.1)	76.8 (0.1)	80.7 (0.1)	73.1 (0.1)	77.8 (0.8)
Dew Point Temperature (°F)	55.1 (0.5)	58.1 (0.4)	68.9 (0.2)	54.2 (0.4)	54.4 (0.1)	54.5 (0.2)	65.5 (0.3)	73.2 (0.2)	49.6 (1.1)	60.3 (0.8)
Wet Bulb Temperature (°F)	60.4 (0.3)	62.7 (0.3)	70.8 (0.2)	61.1 (0.2)	61.3 (0.2)	61.2 (0.1)	69.0 (0.2)	75.2 (0.1)	59.1 (0.6)	66.2 (0.6)
Relative Humidity (%)	61.0	64.1	79.7	52.5	52.3	53.3	68.2	77.9	43.4	54.9
External Resistance (IW)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Exhaust Air Properties										
Dry Bulb Temperature (°F)	79.2 (0.1)	80.7 (0.1)	82.3 (0.1)	84.2 (0.5)	84.1 (0.4)	84.3 (0.1)	86.7 (0.1)	88.7 (0.0)	88.0 (0.2)	90.4 (0.4)
Dew Point Temperature (°F)	77.7 (0.1)	79.3 (0.1)	81.5 (0.1)	83.2 (0.2)	82.8 (0.3)	83.0 (0.1)	85.5 (0.1)	87.6 (0.0)	87.1 (0.1)	88.8 (0.2)
Wet Bulb Temperature (°F)	78.1 (0.1)	79.6 (0.1)	81.7 (0.1)	83.4 (0.2)	83.1 (0.2)	83.3 (0.1)	85.8 (0.1)	87.8 (0.0)	87.3 (0.1)	89.1 (0.2)
Relative Humidity (%)	95.2	95.4	97.3	97.0	95.9	96.0	96.4	96.7	97.2	95.2
Power Consumption										
Voltage (V)	239	241	239	238	241	241	241	243	243	243
Current (A)	5.7	5.6	5.7	5.8	5.7	5.7	5.7	5.6	5.8	5.8
Power (W)	1,336 (3.3)	1,334 (3.8)	1,341 (3.6)	1,352 (4.0)	1,353 (3.2)	1,352 (5.9)	1,349 (5.1)	1,345 (6.0)	1,379 (3.9)	1,384 (3.8)
Power Factor	0.99	0.99	0.99	0.99	0.99	0.98	0.99	0.98	0.98	0.98
Fan Speed (RPM)	2,007 (1.8)	2,011 (1.8)	2,020 (1.6)	2,025 (4.0)	2,027 (2.3)	2,027 (2.6)	2,031 (2.2)	2,029 (2.8)	2,058 (2.0)	2,064 (1.9)
Fan Speed Setting	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
Performance										
Dry Bulb Temperature Drop (°F)	20.9	20.2	14.5	27.3	27.4	27.7	23.3	19.3	36.7	32.5
Wet-Bulb Effectiveness (%)	86.7	91.7	96.3	90.3	90.8	92.2	91.8	95.2	92.2	91.4
"Indirect" Effectiveness (%)	39.4	57.1	71.4	52.6	55.0	56.1	52.8	65.6	47.8	53.0
Supply Airflow Rate (CFM)	1,601	1,632	1,596	1,603	1,603	1,607	1,619	1,618	1,598	1,612
Room Capacity (tons; 80°F reference)	1.54	1.32	0.61	1.05	1.01	1.08	0.46	-0.11	0.96	0.31
Room EER (Btu/Wh, 80°F reference)	13.8	11.8	5.5	9.3	8.9	9.5	4.1	-0.9	8.3	2.7
CA T-20 ECER (Btu/Wh)*	-	-	-	-	-	-	-	-	-	-
Sensible Cooling of Outside Air (tons)	2.96	2.91	2.02	3.86	3.87	3.92	3.30	2.70	5.12	4.55
Outside Air EER (Btu/Wh)	26.6	26.1	18.1	34.2	34.3	34.8	29.3	24.1	44.6	39.4

* ECER can only be derived when the supply resistance is 0.3" and the intake wet-bulb depression is >=25°F

Table 5: Climate Wizard Test Data – Continued

Test Summary Information	Tests at Maximum Fan Speed and 0.3 IWC Supply Reistance										
General [Average (Std. Dev)]											
Date (2009)	8-Jul	18-Jun	29-Jun	30-Jun	25-Jun	26-Jun	18-Jun	29-Jun	29-Jun	29-Jun	30-Jun
Start Time	1:00p	12:29p	11:49a	11:16a	2:48p	12:07p	1:40p	5:07p	1:49p	2:28p	3:31p
Duration (minutes)	25	15	20	25	20	20	12	9	20	12	20
Barometric Pressure (in. of Hg)	29.39	29.36	29.32	29.32	29.42	29.45	29.37	29.27	29.28	29.30	29.26
Inlet Air Properties											
Dry Bulb Temperature (°F)	89.9 (0.4)	91.3 (0.3)	91.2 (0.3)	90.1 (0.2)	99.6 (0.4)	100.3 (0.3)	100.1 (0.2)	110.0 (0.5)	110.4 (0.4)	110.7 (0.4)	120.1 (0.7)
Dew Point Temperature (°F)	53.6 (1.4)	58.5 (0.1)	57.9 (0.6)	69.1 (0.2)	55.2 (0.3)	53.4 (0.2)	64.1 (0.1)	45.6 (0.5)	58.7 (0.4)	59.2 (0.3)	63.3 (0.6)
Wet Bulb Temperature (°F)	66.6 (0.6)	69.4 (0.1)	69.0 (0.4)	75.0 (0.1)	70.3 (0.2)	69.7 (0.2)	74.8 (0.1)	69.6 (0.2)	74.8 (0.2)	75.1 (0.2)	79.4 (0.3)
Wet Bulb Depression (°F)	23.3	21.9	22.1	15.1	29.3	30.5	25.4	40.4	35.6	35.6	40.8
Relative Humidity (%)	29.2	33.3	32.8	50.2	23.0	21.1	31.1	11.8	18.9	19.1	16.9
Supply Air Properties											
Dry Bulb Temperature (°F)	67.3 (0.4)	70.8 (0.1)	68.6 (0.3)	74.5 (0.2)	71.1 (0.3)	70.2 (0.4)	75.0 (0.1)	69.9 (0.2)	74.1 (0.3)	75.3 (0.3)	77.5 (0.3)
Dew Point Temperature (°F)	55.4 (0.9)	59.8 (0.2)	57.7 (0.6)	68.8 (0.3)	55.2 (0.4)	53.4 (0.3)	65.3 (0.2)	47.3 (0.7)	60.2 (0.6)	60.7 (0.6)	64.2 (0.5)
Wet Bulb Temperature (°F)	59.9 (0.6)	63.6 (0.1)	61.7 (0.4)	70.5 (0.2)	61.2 (0.1)	59.9 (0.2)	68.3 (0.1)	56.8 (0.3)	65.0 (0.4)	65.6 (0.4)	68.4 (0.4)
Relative Humidity (%)	65.4	68.3	68.2	82.5	57.0	55.1	71.7	44.6	61.8	60.5	63.6
External Resistance (IW)	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**
Exhaust Air Properties											
Dry Bulb Temperature (°F)	77.1 (0.3)	78.9 (0.1)	78.6 (0.3)	80.8 (0.1)	81.6 (0.2)	81.5 (0.2)	84.5 (0.1)	84.4 (0.1)	87.7 (0.1)	87.7 (0.3)	92.3 (0.2)
Dew Point Temperature (°F)	76.0 (0.2)	78.1 (0.1)	77.7 (0.2)	80.2 (0.1)	80.9 (0.2)	80.5 (0.1)	83.7 (0.1)	83.7 (0.1)	86.5 (0.1)	86.6 (0.2)	91.0 (0.2)
Wet Bulb Temperature (°F)	76.3 (0.2)	78.3 (0.1)	77.9 (0.2)	80.3 (0.1)	81.0 (0.2)	80.7 (0.1)	83.9 (0.1)	83.9 (0.0)	86.8 (0.1)	86.8 (0.2)	91.2 (0.1)
Relative Humidity (%)	96.5	97.2	97.1	98.0	97.8	96.9	97.4	98.0	96.5	96.6	96.0
Power Consumption											
Voltage (V)	240	241	242	239	238	238	241	243	243	242	240
Current (A)	5.7	5.6	5.6	5.7	5.8	5.8	5.7	5.8	5.8	5.8	5.8
Power (W)	1,343 (3.9)	1,334 (3.2)	1,342 (4.4)	1,350 (4.4)	1,359 (4.9)	1,360 (4.2)	1,356 (2.8)	1,383 (4.3)	1,390 (3.2)	1,391 (2.9)	1,377 (3.4)
Power Factor	0.99	0.98	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.99
Fan Speed (RPM)	2,019 (2.4)	2,017 (1.7)	2,025 (2.2)	2,033 (2.3)	2,035 (2.5)	2,038 (2.3)	2,043 (1.4)	2,068 (1.8)	2,075 (1.7)	2,077 (1.6)	2,082 (2.0)
Fan Speed Setting	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
Performance											
Dry Bulb Temperature Drop (°F)	22.6	20.5	22.5	15.6	28.4	30.0	25.1	40.1	36.2	35.5	42.6
Wet-Bulb Effectiveness (%)	97.0	93.7	101.7	103.4	97.1	98.4	99.0	99.3	101.8	99.6	104.5
"Indirect" Effectiveness (%)	51.7	52.7	65.7	76.6	60.7	60.4	60.4	53.3	60.9	59.6	68.0
Supply Airflow Rate (CFM)	1,346	1,358	1,363	1,338	1,336	1,345	1,367	1,332	1,351	1,351	1,339
Room Capacity (tons; 80°F reference)	1.51	1.11	1.37	0.65	1.05	1.17	0.60	1.18	0.70	0.56	0.29
Room EER (Btu/Wh, 80°F reference)	13.5	9.9	12.2	5.8	9.2	10.3	5.3	10.3	6.0	4.8	2.5
CA T-20 ECER (Btu/Wh)[*]	-	-	-	-	11.6	12.0	12.2	12.1	12.7	12.2	13.5
Sensible Cooling of Outside Air (tons)	2.70	2.46	2.71	1.83	3.35	3.58	3.00	4.70	4.28	4.18	4.95
Outside Air EER (Btu/Wh)	24.1	22.1	24.3	16.3	29.6	31.6	26.6	40.7	37.0	36.1	43.2

[*] ECER can only be derived when the supply resistance is 0.3" and the intake wet-bulb depression is >=25°F

Table 5: Climate Wizard Test Data – Continued

Test Summary Information	Tests at 100°F_{db} / 75°F_{wb}, Maximum Speed, Variable Resistance								
General [Average (Std. Dev)]									
Date (2009)	18-Jun	24-Jun	18-Jun	18-Jun	18-Jun	18-Jun	18-Jun	18-Jun	25-Jun
Start Time	2:58p	5:26p	2:29p	3:16p	1:54p	1:40p	3:55p	4:25p	4:10p
Duration (minutes)	15	12	15	8	10	12	10	20	20
Barometric Pressure (in. of Hg)	29.36	29.30	29.36	29.34	29.36	29.37	29.32	29.32	29.41
Inlet Air Properties									
Dry Bulb Temperature (°F)	100.1 (0.2)	100.0 (0.1)	100.1 (0.2)	99.8 (0.1)	100.1 (0.2)	100.1 (0.2)	99.8 (0.2)	99.9 (0.2)	99.9 (1.9)
Dew Point Temperature (°F)	64.0 (0.3)	72.8 (0.2)	63.1 (0.3)	64.5 (0.1)	63.7 (0.1)	64.1 (0.1)	65.7 (0.2)	65.0 (0.3)	53.5 (0.2)
Wet Bulb Temperature (°F)	74.7 (0.2)	79.8 (0.1)	74.2 (0.2)	74.9 (0.1)	74.6 (0.1)	74.8 (0.1)	75.5 (0.1)	75.2 (0.2)	69.6 (0.6)
Wet Bulb Depression (°F)	25.4	20.2	25.9	24.9	25.5	25.4	24.3	24.8	30.3
Relative Humidity (%)	30.9	42.1	30.0	31.8	30.7	31.1	33.0	32.2	21.4
Supply Air Properties									
Dry Bulb Temperature (°F)	76.8 (0.1)	80.7 (0.1)	75.8 (0.2)	76.0 (0.0)	75.6 (0.1)	75.0 (0.1)	74.5 (0.1)	73.0 (0.1)	72.6 (0.3)
Dew Point Temperature (°F)	65.5 (0.3)	73.2 (0.2)	64.5 (0.2)	65.5 (0.1)	65.0 (0.2)	65.3 (0.2)	65.7 (0.1)	64.5 (0.2)	54.2 (0.4)
Wet Bulb Temperature (°F)	69.0 (0.2)	75.2 (0.1)	68.1 (0.2)	68.8 (0.1)	68.4 (0.1)	68.3 (0.1)	68.5 (0.1)	67.3 (0.1)	61.1 (0.2)
Relative Humidity (%)	68.2	77.9	68.0	69.9	69.7	71.7	73.9	74.7	52.5
External Resistance (IW)	**0.00**	**0.00**	**0.10**	**0.15**	**0.20**	**0.30**	**0.50**	**0.75**	**0.00**
Exhaust Air Properties									
Dry Bulb Temperature (°F)	86.7 (0.1)	88.7 (0.0)	85.7 (0.1)	85.5 (0.0)	85.2 (0.1)	84.5 (0.1)	83.3 (0.0)	81.4 (0.0)	84.2 (0.5)
Dew Point Temperature (°F)	85.5 (0.1)	87.6 (0.0)	84.6 (0.1)	84.7 (0.2)	84.2 (0.2)	83.7 (0.1)	82.7 (0.0)	81.1 (0.0)	83.2 (0.2)
Wet Bulb Temperature (°F)	85.8 (0.1)	87.8 (0.0)	84.8 (0.1)	84.9 (0.2)	84.4 (0.2)	83.9 (0.1)	82.8 (0.0)	81.2 (0.0)	83.4 (0.2)
Relative Humidity (%)	96.4	96.7	96.5	97.4	96.9	97.4	98.2	99.0	97.0
Power Consumption									
Voltage (V)	241	243	241	241	241	241	241	240	238
Current (A)	5.7	5.6	5.7	5.7	5.7	5.7	5.7	5.8	5.8
Power (W)	1,349 (5.1)	1,345 (6.0)	1,351 (4.6)	1,352 (4.1)	1,354 (3.6)	1,356 (2.8)	1,360 (2.8)	1,369 (4.0)	1,352 (4.0)
Power Factor	0.99	0.98	0.99	0.99	0.98	0.99	0.99	0.99	0.99
Fan Speed (RPM)	2,031 (2.2)	2,029 (2.8)	2,033 (2.1)	2,036 (1.9)	2,038 (1.7)	2,043 (1.4)	2,052 (1.3)	2,068 (1.9)	2,025 (4.0)
Fan Speed Setting	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
Performance									
Dry Bulb Temperature Drop (°F)	23.3	19.3	24.3	23.8	24.5	25.1	25.3	26.9	27.3
Wet-Bulb Effectiveness (%)	91.8	95.2	93.9	95.4	95.9	99.0	104.0	108.7	90.3
"Indirect" Effectiveness (%)	52.8	65.6	55.4	58.7	57.4	60.4	71.6	77.8	52.6
Supply Airflow Rate (CFM)	1,619	1,618	1,530	1,486	1,452	1,367	1,186	978	1,603
Room Capacity (tons; 80°F reference)	0.46	-0.11	0.56	0.52	0.56	0.60	0.57	0.60	1.05
Room EER (Btu/Wh, 80°F reference)	4.1	-0.9	5.0	4.6	4.9	5.3	5.0	5.2	9.3
CA T-20 ECER (Btu/Wh)*	-	-	-	-	-	12.2	-	-	-
Sensible Cooling of Outside Air (tons)	3.30	2.70	3.25	3.08	3.11	3.00	2.63	2.31	3.86
Outside Air EER (Btu/Wh)	29.3	24.1	28.8	27.3	27.5	26.6	23.2	20.2	34.2

* ECER can only be derived when the supply resistance is 0.3" and the intake wet-bulb depression is >=25°F

Table 5: Climate Wizard Test Data – Continued

Test Summary Information	Tests at 100°F_{db} / 70°F_{wb}, Variable Speed and Resistance									
General [Average (Std. Dev)]										
Date (2009)	26-Jun	26-Jun	25-Jun	26-Jun	25-Jun	25-Jun	26-Jun	26-Jun	26-Jun	2-Jul
Start Time	1:40p	2:03p	3:29p	12:53p	2:48p	4:46p	11:31a	10:54a	11:19a	3:12p
Duration (minutes)	9	15	20	15	20	15	15	12	7	25
Barometric Pressure (in. of Hg)	29.43	29.43	29.42	29.44	29.42	29.41	29.46	29.46	29.46	29.32
Inlet Air Properties										
Dry Bulb Temperature (°F)	100.3 (0.9)	100.1 (0.5)	100.3 (1.5)	99.1 (0.4)	99.6 (0.4)	99.6 (1.2)	100.1 (0.6)	100.1 (0.5)	100.4 (0.4)	100.0 (0.3)
Dew Point Temperature (°F)	54.2 (0.2)	54.3 (0.2)	54.4 (0.3)	53.3 (0.2)	55.2 (0.3)	53.7 (0.3)	52.8 (0.4)	53.4 (0.2)	53.9 (0.2)	55.4 (0.4)
Wet Bulb Temperature (°F)	70.1 (0.3)	70.1 (0.2)	70.1 (0.4)	69.3 (0.2)	70.3 (0.2)	69.6 (0.3)	69.4 (0.2)	69.6 (0.2)	70.0 (0.2)	70.5 (0.2)
Wet Bulb Depression (°F)	30.2	30.0	30.2	29.8	29.3	30.0	30.7	30.4	30.4	29.5
Relative Humidity (%)	21.7	21.9	21.8	21.8	23.0	21.7	20.7	21.2	21.4	22.9
Supply Air Properties										
Dry Bulb Temperature (°F)	72.9 (0.4)	72.4 (0.1)	71.8 (0.2)	71.2 (0.3)	71.1 (0.3)	68.7 (0.1)	68.9 (0.4)	67.8 (0.2)	67.9 (0.1)	68.0 (0.2)
Dew Point Temperature (°F)	54.4 (0.1)	54.5 (0.2)	54.7 (0.4)	53.4 (0.3)	55.2 (0.4)	53.8 (0.4)	52.6 (0.3)	53.0 (0.2)	53.5 (0.1)	57.0 (0.5)
Wet Bulb Temperature (°F)	61.3 (0.2)	61.2 (0.1)	61.1 (0.2)	60.2 (0.2)	61.2 (0.1)	59.6 (0.2)	59.0 (0.2)	58.8 (0.1)	59.1 (0.1)	61.0 (0.3)
Relative Humidity (%)	52.3	53.3	55.0	53.5	57.0	59.0	56.2	59.2	60.0	67.7
External Resistance (IW)	**0.00**	**0.00**	**0.15**	**0.15**	**0.30**	**0.50**	**0.50**	**0.70**	**0.70**	**0.75**
Exhaust Air Properties										
Dry Bulb Temperature (°F)	84.1 (0.4)	84.3 (0.1)	83.1 (0.4)	82.2 (0.2)	81.6 (0.2)	79.6 (0.2)	79.7 (0.3)	78.1 (0.2)	78.2 (0.1)	78.7 (0.2)
Dew Point Temperature (°F)	82.8 (0.3)	83.0 (0.1)	82.2 (0.3)	81.3 (0.2)	80.9 (0.2)	79.1 (0.2)	78.7 (0.2)	77.2 (0.1)	77.7 (0.1)	78.3 (0.2)
Wet Bulb Temperature (°F)	83.1 (0.2)	83.3 (0.1)	82.4 (0.3)	81.5 (0.1)	81.0 (0.2)	79.2 (0.1)	79.0 (0.2)	77.4 (0.1)	77.8 (0.1)	78.4 (0.2)
Relative Humidity (%)	95.9	96.0	97.2	97.1	97.8	98.4	96.9	97.3	98.3	98.5
Power Consumption										
Voltage (V)	241	241	239	239	238	238	239	237	238	240
Current (A)	5.7	5.7	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.7
Power (W)	1,353 (3.2)	1,352 (5.9)	1,356 (4.7)	1,356 (4.5)	1,359 (4.9)	1,364 (3.2)	1,364 (2.8)	1,364 (3.2)	1,369 (5.2)	1,352 (4.1)
Power Factor	0.99	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98
Fan Speed (RPM)	2,027 (2.3)	2,027 (2.6)	2,030 (3.1)	2,030 (2.4)	2,035 (2.5)	2,047 (3.3)	2,046 (1.9)	2,054 (1.8)	2,059 (2.4)	2,059 (2.4)
Fan Speed Setting	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
Performance										
Dry Bulb Temperature Drop (°F)	27.4	27.7	28.5	27.9	28.4	30.9	31.3	32.3	32.5	32.0
Wet-Bulb Effectiveness (%)	90.8	92.2	94.6	93.8	97.1	103.0	101.7	106.1	107.0	108.3
"Indirect" Effectiveness (%)	55.0	56.1	57.1	56.7	60.7	63.1	62.4	66.5	68.0	62.6
Supply Airflow Rate (CFM)	1,603	1,607	1,471	1,477	1,336	1,170	1,173	1,001	1,013	935
Room Capacity (tons; 80°F reference)	1.01	1.08	1.07	1.15	1.05	1.17	1.16	1.09	1.10	0.99
Room EER (Btu/Wh, 80°F reference)	8.9	9.5	9.5	10.2	9.2	10.3	10.2	9.6	9.6	8.8
CA T-20 ECER (Btu/Wh)[*]	-	-	-	-	11.6	-	-	-	-	-
Sensible Cooling of Outside Air (tons)	3.87	3.92	3.70	3.64	3.35	3.21	3.26	2.88	2.93	2.65
Outside Air EER (Btu/Wh)	34.3	34.8	32.8	32.2	29.6	28.2	28.7	25.4	25.7	23.5

[*] ECER can only be derived when the supply resistance is 0.3" and the intake wet-bulb depression is >=25°F

Table 5: Climate Wizard Test Data – Continued

Test Summary Information	Tests at 100°F$_{db}$ / 70°F$_{wb}$, Variable Speed and Resistance										
General **[Average (Std. Dev)]**											
Date (2009)	26-Jun	26-Jun	26-Jun	26-Jun	26-Jun	2-Jul	2-Jul	2-Jul	2-Jul	2-Jul	2-Jul
Start Time	2:21p	2:45p	3:03p	3:30p	4:06p	2:31p	10:30a	11:11a	12:31p	1:11p	1:51p
Duration (minutes)	8	15	7	20	25	25	25	25	25	25	25
Barometric Pressure (in. of Hg)	29.42	29.40	29.40	29.39	29.38	29.32	29.34	29.34	29.34	29.33	29.33
Inlet Air Properties											
Dry Bulb Temperature (°F)	100.2 (0.5)	100.1 (0.5)	100.0 (0.5)	99.7 (0.3)	99.7 (0.6)	99.9 (0.4)	100.2 (0.4)	100.2 (0.3)	100.0 (0.4)	100.1 (0.4)	100.0 (0.4)
Dew Point Temperature (°F)	54.0 (0.3)	54.1 (0.3)	54.5 (0.2)	54.5 (0.2)	55.3 (0.3)	54.7 (0.2)	53.1 (0.2)	54.0 (0.3)	54.7 (0.2)	54.0 (0.3)	55.1 (0.3)
Wet Bulb Temperature (°F)	69.9 (0.2)	70.0 (0.2)	70.1 (0.1)	70.0 (0.1)	70.4 (0.2)	70.1 (0.2)	69.5 (0.2)	69.9 (0.2)	70.2 (0.1)	69.9 (0.2)	70.3 (0.2)
Wet Bulb Depression (°F)	30.3	30.1	29.9	29.7	29.3	29.8	30.6	30.3	29.8	30.2	29.6
Relative Humidity (%)	21.5	21.7	22.1	22.3	23.0	22.3	20.9	21.6	22.3	21.6	22.6
Supply Air Properties											
Dry Bulb Temperature (°F)	72.6 (0.1)	70.9 (0.1)	70.3 (0.1)	68.8 (0.3)	68.1 (0.4)	67.1 (0.1)	71.8 (0.1)	70.5 (0.1)	69.4 (0.1)	67.6 (0.2)	66.8 (0.1)
Dew Point Temperature (°F)	54.1 (0.2)	54.2 (0.2)	54.2 (0.2)	54.1 (0.2)	54.7 (0.3)	56.2 (0.2)	56.5 (0.5)	57.2 (0.4)	57.3 (0.3)	56.1 (0.4)	56.4 (0.3)
Wet Bulb Temperature (°F)	61.1 (0.1)	60.5 (0.1)	60.4 (0.1)	59.7 (0.2)	59.8 (0.3)	60.3 (0.1)	62.1 (0.3)	62.0 (0.2)	61.7 (0.2)	60.4 (0.3)	60.3 (0.2)
Relative Humidity (%)	52.1	55.6	56.7	59.5	62.2	68.0	58.5	62.6	65.5	66.7	69.2
External Resistance (IW)	**0.00**	**0.15**	**0.30**	**0.50**	**0.70**	**0.75**	**0.00**	**0.15**	**0.30**	**0.50**	**0.75**
Exhaust Air Properties											
Dry Bulb Temperature (°F)	84.2 (0.1)	82.8 (0.1)	81.4 (0.1)	79.5 (0.2)	78.1 (0.3)	78.1 (0.1)	84.6 (0.1)	83.2 (0.1)	81.6 (0.1)	79.5 (0.1)	77.1 (0.1)
Dew Point Temperature (°F)	83.0 (0.0)	81.7 (0.0)	80.8 (0.1)	78.9 (0.1)	77.7 (0.2)	77.6 (0.1)	82.6 (0.1)	81.7 (0.1)	80.3 (0.1)	78.8 (0.1)	76.8 (0.1)
Wet Bulb Temperature (°F)	83.2 (0.0)	82.0 (0.0)	81.0 (0.1)	79.0 (0.1)	77.8 (0.2)	77.7 (0.1)	83.0 (0.1)	82.0 (0.1)	80.6 (0.1)	79.0 (0.1)	76.8 (0.1)
Relative Humidity (%)	96.1	96.7	98.0	97.9	98.9	98.3	93.9	95.3	95.8	98.0	98.8
Power Consumption											
Voltage (V)	241	241	241	241	242	240	238	238	239	239	241
Current (A)	5.2	5.2	5.2	5.3	5.2	5.2	4.2	4.3	4.3	4.3	4.2
Power (W)	1,237 (3.1)	1,236 (4.4)	1,241 (3.9)	1,244 (3.0)	1,224 (2.9)	1,232 (3.3)	992 (2.4)	995 (2.7)	999 (2.9)	1,004 (2.9)	988 (2.7)
Power Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Fan Speed (RPM)	1,964 (2.0)	1,969 (2.6)	1,977 (2.4)	1,986 (1.9)	1,986 (2.2)	1,997 (1.9)	1,821 (1.6)	1,828 (1.7)	1,836 (1.6)	1,849 (1.9)	1,854 (1.8)
Fan Speed Setting	**8**	**8**	**8**	**8**	**8**	**8**	**6**	**6**	**6**	**6**	**6**
Performance											
Dry Bulb Temperature Drop (°F)	27.6	29.2	29.7	30.9	31.6	32.8	28.4	29.6	30.6	32.5	33.2
Wet-Bulb Effectiveness (%)	91.1	97.0	99.2	104.1	107.6	110.1	92.7	97.8	102.7	107.7	112.0
"Indirect" Effectiveness (%)	55.2	59.5	62.2	66.0	70.1	63.6	45.6	49.3	54.8	59.8	66.1
Supply Airflow Rate (CFM)	1,551	1,417	1,281	1,106	919	866	1,438	1,281	1,131	946	692
Room Capacity (tons; 80°F reference)	1.00	1.14	1.10	1.10	0.97	0.99	1.04	1.07	1.06	1.04	0.81
Room EER (Btu/Wh, 80°F reference)	9.7	11.1	10.6	10.6	9.5	9.7	12.6	12.9	12.8	12.5	9.9
CA T-20 ECER (Btu/Wh)*	-	-	12.7	-	-	-	-	-	14.9	-	-
Sensible Cooling of Outside Air (tons)	3.76	3.65	3.36	3.03	2.57	2.53	3.60	3.35	3.06	2.73	2.04
Outside Air EER (Btu/Wh)	36.5	35.5	32.5	29.2	25.2	24.6	43.5	40.3	36.7	32.6	24.8

* ECER can only be derived when the supply resistance is 0.3" and the intake wet-bulb depression is >=25°F

Table 5: Climate Wizard Test Data – Continued

Test Summary Information	Tests at 100°F$_{db}$ / 70°F$_{wb}$, Variable Speed and Resistance											
General [Average (Std. Dev)]												
Date (2009)	8-Jul	8-Jul	8-Jul	2-Jul	2-Jul	8-Jul	10-Jul	10-Jul	10-Jul	9-Jul	10-Jul	10-Jul
Start Time	3:41p	3:01p	2:25p	4:38p	4:03p	4:21p	10:48a	8:53a	8:09a	11:21a	10:05a	9:32a
Duration (minutes)	25	25	20	20	14	25	20	20	25	20	25	20
Barometric Pressure (in. of Hg)	29.36	29.37	29.38	29.31	29.31	29.36	29.52	29.50	29.51	29.45	29.52	29.52
Inlet Air Properties												
Dry Bulb Temperature (°F)	100.0 (0.7)	100.1 (0.5)	100.2 (0.4)	99.9 (0.4)	100.2 (0.4)	100.3 (0.8)	100.0 (0.3)	100.1 (0.2)	100.1 (0.2)	100.0 (0.2)	100.1 (0.2)	99.7 (1.0)
Dew Point Temperature (°F)	54.2 (0.3)	54.4 (0.2)	53.8 (0.3)	54.2 (0.1)	53.3 (0.2)	53.9 (0.4)	55.1 (0.1)	55.4 (0.1)	55.4 (0.1)	54.5 (0.1)	54.3 (0.1)	54.1 (0.1)
Wet Bulb Temperature (°F)	69.9 (0.2)	70.1 (0.2)	69.9 (0.2)	69.9 (0.1)	69.6 (0.2)	69.9 (0.3)	70.4 (0.1)	70.6 (0.1)	70.6 (0.1)	70.1 (0.1)	70.1 (0.1)	69.8 (0.3)
Wet Bulb Depression (°F)	30.0	30.1	30.4	30.0	30.6	30.4	29.6	29.6	29.5	29.9	30.0	29.8
Relative Humidity (%)	21.9	21.9	21.4	21.9	21.1	21.5	22.6	22.8	22.8	22.1	21.9	22.0
Supply Air Properties												
Dry Bulb Temperature (°F)	72.7 (0.3)	71.0 (0.2)	69.3 (0.1)	66.7 (0.1)	65.8 (0.1)	71.9 (0.1)	69.5 (0.3)	67.6 (0.2)	67.8 (0.1)	71.9 (0.2)	68.3 (0.4)	68.2 (0.1)
Dew Point Temperature (°F)	57.6 (0.4)	57.6 (0.4)	56.7 (0.4)	55.4 (0.2)	54.5 (0.3)	56.3 (0.4)	57.1 (0.2)	57.1 (0.1)	57.0 (0.1)	56.1 (0.2)	56.2 (0.2)	55.7 (0.1)
Wet Bulb Temperature (°F)	63.0 (0.3)	62.4 (0.2)	61.3 (0.2)	59.7 (0.1)	58.8 (0.2)	62.0 (0.2)	61.7 (0.2)	61.0 (0.1)	61.0 (0.1)	61.9 (0.2)	60.7 (0.2)	60.4 (0.1)
Relative Humidity (%)	59.0	62.7	64.4	67.1	66.8	57.9	64.8	68.9	68.4	57.5	65.2	64.4
External Resistance (IW)	**0.00**	**0.15**	**0.30**	**0.50**	**0.75**	**0.00**	**0.15**	**0.30**	**0.48**	**0.00**	**0.15**	**0.27**
Exhaust Air Properties												
Dry Bulb Temperature (°F)	85.1 (0.2)	82.9 (0.2)	81.0 (0.1)	77.9 (0.1)	74.9 (0.1)	86.0 (0.2)	81.7 (0.2)	77.9 (0.2)	73.9 (0.1)	88.0 (0.1)	80.0 (0.3)	73.5 (0.2)
Dew Point Temperature (°F)	83.0 (0.2)	81.3 (0.3)	79.5 (0.1)	77.1 (0.1)	74.7 (0.1)	78.7 (0.8)	77.5 (0.5)	75.9 (0.1)	72.8 (0.1)	72.4 (0.5)	70.9 (0.7)	70.2 (0.4)
Wet Bulb Temperature (°F)	83.5 (0.1)	81.7 (0.3)	79.9 (0.1)	77.3 (0.1)	74.8 (0.1)	80.4 (0.6)	78.6 (0.4)	76.4 (0.1)	73.1 (0.1)	76.5 (0.3)	73.5 (0.4)	71.2 (0.3)
Relative Humidity (%)	93.6	94.8	95.4	97.2	99.4	78.8	87.2	93.7	96.3	59.9	74.0	89.2
Power Consumption												
Voltage (V)	240	240	240	242	242	240	239	238	238	239	238	238
Current (A)	3.3	3.2	3.2	3.2	3.2	1.5	1.5	1.5	1.5	0.7	0.7	0.8
Power (W)	770 (2.3)	750 (3.2)	756 (2.2)	761 (3.0)	750 (1.9)	340 (2.8)	338 (0.9)	330 (0.6)	334 (1.1)	164 (0.9)	163 (0.5)	166 (0.3)
Power Factor	0.98	0.98	0.98	0.97	0.97	0.95	0.96	0.96	0.96	0.93	0.93	0.93
Fan Speed (RPM)	1,660 (2.4)	1,648 (2.9)	1,658 (1.8)	1,677 (2.4)	1,690 (1.6)	1,212 (4.2)	1,218 (1.0)	1,215 (1.0)	1,242 (2.2)	880 (0.6)	893 (1.1)	915 (1.5)
Fan Speed Setting	**4**	**4**	**4**	**4**	**4**	**2**	**2**	**2**	**2**	**1**	**1**	**1**
Performance												
Dry Bulb Temperature Drop (°F)	27.3	29.2	31.0	33.2	34.4	28.4	30.5	32.5	32.3	28.1	31.8	31.5
Wet-Bulb Effectiveness (%)	90.8	97.1	102.0	110.8	112.5	93.5	103.0	109.9	109.5	94.1	105.9	105.6
"Indirect" Effectiveness (%)	44.0	48.7	53.1	65.0	66.1	49.5	57.0	63.2	63.4	52.5	59.4	59.9
Supply Airflow Rate (CFM)	1,308	1,128	972	748	458	946	738	504	237	700	420	177
Room Capacity (tons; 80°F reference)	0.84	0.90	0.93	0.89	0.58	0.67	0.69	0.56	0.26	0.50	0.44	0.19
Room EER (Btu/Wh, 80°F reference)	13.1	14.4	14.7	14.0	9.3	23.7	24.5	20.2	9.3	36.9	32.2	13.5
CA T-20 ECER (Btu/Wh) *	-	-	16.8	-	-	-	-	23.0	-	-	-	-
Sensible Cooling of Outside Air (tons)	3.14	2.91	2.67	2.21	1.40	2.36	2.00	1.46	0.68	1.74	1.19	0.50
Outside Air EER (Btu/Wh)	48.8	46.5	42.3	34.8	22.4	83.2	71.0	53.2	24.6	127.3	87.4	35.9

* ECER can only be derived when the supply resistance is 0.3" and the intake wet-bulb depression is >=25°F

Table 5: Climate Wizard Test Data – Continued

Test Summary Information	Short Tests at Zero Resistance and Each Fan Speed									
General **[Average (Std. Dev)]**										
Date (2009)	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul
Start Time	11:22a	11:27a	11:31a	11:36a	11:44a	11:48a	11:53a	11:59a	12:08p	12:13p
Duration (minutes)	4	4	5	8	3	4	5	9	4	4
Barometric Pressure (in. of Hg)	29.51	29.52	29.51	29.51	29.51	29.51	29.51	29.51	29.51	29.50
Inlet Air Properties										
Dry Bulb Temperature (°F)	100.4 (0.3)	99.6 (0.3)	99.9 (0.3)	100.0 (0.6)	100.5 (0.3)	99.8 (0.3)	100.3 (0.2)	99.9 (0.5)	99.8 (0.4)	100.1 (0.4)
Dew Point Temperature (°F)	53.4 (0.2)	54.3 (0.3)	55.1 (0.3)	55.7 (0.2)	55.6 (0.0)	55.7 (0.1)	55.5 (0.1)	56.1 (0.2)	55.9 (0.2)	56.0 (0.2)
Wet Bulb Temperature (°F)	69.8 (0.1)	69.9 (0.2)	70.3 (0.2)	70.7 (0.2)	70.8 (0.1)	70.6 (0.1)	70.6 (0.1)	70.8 (0.2)	70.7 (0.1)	70.8 (0.1)
Wet Bulb Depression (°F)	30.6	29.7	29.5	29.4	29.8	29.2	29.7	29.1	29.1	29.3
Relative Humidity (%)	21.0	22.2	22.7	23.1	22.7	23.2	22.7	23.5	23.4	23.3
Supply Air Properties										
Dry Bulb Temperature (°F)	73.2 (0.0)	73.1 (0.1)	73.0 (0.0)	72.9 (0.2)	72.7 (0.0)	72.7 (0.1)	72.6 (0.0)	72.8 (0.1)	72.8 (0.1)	73.0 (0.0)
Dew Point Temperature (°F)	56.1 (0.2)	57.0 (0.2)	57.8 (0.3)	58.8 (0.3)	58.5 (0.2)	58.7 (0.2)	58.6 (0.2)	59.3 (0.3)	58.9 (0.4)	59.0 (0.3)
Wet Bulb Temperature (°F)	62.4 (0.1)	62.8 (0.1)	63.2 (0.2)	63.8 (0.2)	63.5 (0.1)	63.6 (0.1)	63.6 (0.1)	64.0 (0.2)	63.8 (0.2)	63.9 (0.2)
Relative Humidity (%)	55.1	56.9	58.9	61.1	61.2	61.5	61.4	62.5	61.7	61.5
External Resistance (IW)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Exhaust Air Properties										
Dry Bulb Temperature (°F)	88.3 (0.2)	86.7 (0.4)	85.4 (0.3)	85.0 (0.2)	85.0 (0.1)	84.9 (0.1)	85.2 (0.1)	85.2 (0.2)	85.1 (0.1)	85.3 (0.1)
Dew Point Temperature (°F)	67.0 (1.0)	74.9 (1.4)	80.0 (1.2)	80.9 (0.3)	81.4 (0.3)	82.1 (0.1)	82.6 (0.2)	83.0 (0.2)	83.2 (0.1)	83.7 (0.8)
Wet Bulb Temperature (°F)	73.3 (0.6)	78.0 (0.8)	81.3 (0.9)	81.8 (0.2)	82.2 (0.2)	82.7 (0.1)	83.2 (0.2)	83.5 (0.1)	83.6 (0.1)	84.0 (0.6)
Relative Humidity (%)	49.5	68.3	84.0	87.7	88.9	91.2	92.1	93.2	94.1	95.1
Power Consumption										
Voltage (V)	239	238	238	238	238	238	238	238	237	238
Current (A)	0.8	1.5	2.4	3.2	3.7	4.2	4.7	5.2	5.5	5.7
Power (W)	169 (1.3)	332 (0.7)	553 (3.0)	747 (3.4)	866 (2.9)	988 (3.5)	1,101 (3.6)	1,221 (5.6)	1,284 (3.2)	1,347 (5.1)
Power Factor	0.93	0.96	0.97	0.98	0.98	0.98	0.98	0.99	0.99	0.99
Fan Speed (RPM)	895 (0.8)	1,200 (1.4)	1,467 (2.9)	1,644 (2.8)	1,736 (1.5)	1,819 (2.2)	1,892 (2.4)	1,960 (3.5)	1,994 (2.3)	2,028 (3.1)
Fan Speed Setting	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Performance										
Dry Bulb Temperature Drop (°F)	27.2	26.5	26.9	27.1	27.9	27.1	27.7	27.1	27.0	27.2
Wet-Bulb Effectiveness (%)	88.9	89.2	90.9	92.2	93.6	92.9	93.3	93.1	92.7	92.7
"Indirect" Effectiveness (%)	45.2	45.3	46.4	45.9	47.6	46.7	46.6	46.1	46.5	46.6
Supply Airflow Rate (CFM)	723	971	1,178	1,310	1,376	1,440	1,496	1,550	1,578	1,604
Room Capacity (tons; 80°F reference)	0.43	0.59	0.73	0.82	0.89	0.93	0.97	0.98	1.00	1.00
Room EER (Btu/Wh, 80°F reference)	30.9	21.4	15.8	13.1	12.4	11.3	10.6	9.6	9.4	8.9
CA T-20 ECER (Btu/Wh)*	-	-	-	-	-	-	-	-	-	-
Sensible Cooling of Outside Air (tons)	1.74	2.27	2.80	3.13	3.39	3.45	3.66	3.71	3.76	3.84
Outside Air EER (Btu/Wh)	123.7	82.2	60.7	50.4	47.0	41.9	39.9	36.5	35.1	34.2

* ECER can only be derived when the supply resistance is 0.3" and the intake wet-bulb depression is >=25°F

Table 6: Climate Wizard Test Data (SI Units) – Continued

Test Summary Information	Tests at Maximum Fan Speed and Zero Resistance									
General [Average (Std. Dev)]										
Date (2009)	8-Jul	29-Jun	30-Jun	25-Jun	26-Jun	26-Jun	18-Jun	24-Jun	29-Jun	29-Jun
Start Time	1:40p	11:09a	11:58a	4:10p	1:40p	2:03p	2:58p	5:26p	4:27p	3:11p
Duration (minutes)	25	20	30	20	9	15	15	12	15	20
Barometric Pressure (kPa)	99.50	99.32	99.18	99.59	99.67	99.65	99.41	99.24	99.13	99.16
Inlet Air Properties										
Dry Bulb Temperature (°C)	32.3 (0.2)	32.8 (0.1)	32.3 (0.1)	37.7 (1.0)	37.9 (0.5)	37.8 (0.3)	37.8 (0.1)	37.8 (0.0)	43.2 (0.3)	43.5 (0.2)
Dew Point Temperature (°C)	11.1 (0.2)	14.4 (0.2)	20.6 (0.1)	11.9 (0.1)	12.3 (0.1)	12.4 (0.1)	17.8 (0.2)	22.7 (0.1)	8.4 (0.7)	14.8 (0.4)
Wet Bulb Temperature (°C)	18.9 (0.1)	20.6 (0.1)	23.9 (0.1)	20.9 (0.3)	21.1 (0.2)	21.1 (0.1)	23.7 (0.1)	26.5 (0.1)	21.1 (0.3)	23.8 (0.2)
Wet Bulb Depression (°C)	13.4	12.3	8.4	16.8	16.8	16.7	14.1	11.2	22.1	19.8
Relative Humidity (%)	27.3	32.9	50.4	21.4	21.7	21.9	30.9	42.1	12.5	19.0
Supply Air Properties										
Dry Bulb Temperature (°C)	20.6 (0.0)	21.6 (0.1)	24.2 (0.1)	22.5 (0.2)	22.7 (0.2)	22.4 (0.0)	24.9 (0.1)	27.1 (0.0)	22.9 (0.1)	25.4 (0.4)
Dew Point Temperature (°C)	12.9 (0.3)	14.5 (0.2)	20.5 (0.1)	12.3 (0.2)	12.4 (0.1)	12.5 (0.1)	18.6 (0.2)	22.9 (0.1)	9.8 (0.6)	15.7 (0.4)
Wet Bulb Temperature (°C)	15.8 (0.1)	17.0 (0.2)	21.6 (0.1)	16.2 (0.1)	16.3 (0.1)	16.2 (0.1)	20.6 (0.1)	24.0 (0.1)	15.0 (0.3)	19.0 (0.3)
Relative Humidity (%)	61.0	64.1	79.7	52.5	52.3	53.3	68.2	77.9	43.4	54.9
External Resistance (Pa)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Exhaust Air Properties										
Dry Bulb Temperature (°C)	26.2 (0.1)	27.1 (0.1)	28.0 (0.0)	29.0 (0.3)	29.0 (0.2)	29.0 (0.1)	30.4 (0.1)	31.5 (0.0)	31.1 (0.1)	32.4 (0.2)
Dew Point Temperature (°C)	25.4 (0.1)	26.3 (0.1)	27.5 (0.0)	28.5 (0.1)	28.2 (0.2)	28.3 (0.1)	29.7 (0.0)	30.9 (0.0)	30.6 (0.0)	31.5 (0.1)
Wet Bulb Temperature (°C)	25.6 (0.1)	26.5 (0.1)	27.6 (0.0)	28.6 (0.1)	28.4 (0.1)	28.5 (0.0)	29.9 (0.0)	31.0 (0.0)	30.7 (0.1)	31.7 (0.1)
Relative Humidity (%)	95.2	95.4	97.3	97.0	95.9	96.0	96.4	96.7	97.2	95.2
Power Consumption										
Voltage (V)	239	241	239	238	241	241	241	243	243	243
Current (A)	5.7	5.6	5.7	5.8	5.7	5.7	5.7	5.6	5.8	5.8
Power (W)	1,336 (3.3)	1,334 (3.8)	1,341 (3.6)	1,352 (4.0)	1,353 (3.2)	1,352 (5.9)	1,349 (5.1)	1,345 (6.0)	1,379 (3.9)	1,384 (3.8)
Power Factor	0.99	0.99	0.99	0.99	0.99	0.98	0.99	0.98	0.98	0.98
Fan Speed (RPM)	2,007 (1.8)	2,011 (1.8)	2,020 (1.6)	2,025 (4.0)	2,027 (2.3)	2,027 (2.6)	2,031 (2.2)	2,029 (2.8)	2,058 (2.0)	2,064 (1.9)
Fan Speed Setting	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
Performance										
Dry Bulb Temperature Drop (℃)	11.6	11.2	8.1	15.2	15.2	15.4	13.0	10.7	20.4	18.1
Wet-Bulb Effectiveness (%)	86.7	91.7	96.3	90.3	90.8	92.2	91.8	95.2	92.2	91.4
Dew-Point Effectiveness (%)	39.4	57.1	71.4	52.6	55.0	56.1	52.8	65.6	47.8	53.0
Supply Airflow Rate (liters/s)	756	770	753	756	756	759	764	764	754	761
Room Capacity (kW; 26.7°C reference)	5.41	4.62	2.16	3.69	3.54	3.78	1.60	-0.37	3.37	1.08
Room COP (26.7°C reference)	4.0	3.5	1.6	2.7	2.6	2.8	1.2	-0.3	2.4	0.8
Sensible Cooling of Intake Air (kW)	10.42	10.22	7.10	13.56	13.60	13.78	11.59	9.49	18.02	15.99
Intake Air COP	7.8	7.7	5.3	10.0	10.1	10.2	8.6	7.1	13.1	11.6

Table 6: Climate Wizard Test Data (SI Units) – Continued

Test Summary Information	Tests at Maximum Fan Speed and 75 Pa Supply Reistance										
General **[Average (Std. Dev)]**											
Date (2009)	8-Jul	18-Jun	29-Jun	30-Jun	25-Jun	26-Jun	18-Jun	29-Jun	29-Jun	29-Jun	30-Jun
Start Time	1:00p	12:29p	11:49a	11:16a	2:48p	12:07p	1:40p	5:07p	1:49p	2:28p	3:31p
Duration (minutes)	25	15	20	25	20	20	12	9	20	12	20
Barometric Pressure (kPa)	99.51	99.43	99.30	99.27	99.64	99.72	99.45	99.11	99.16	99.22	99.07
Inlet Air Properties											
Dry Bulb Temperature (°C)	32.2 (0.2)	32.9 (0.2)	32.9 (0.2)	32.3 (0.1)	37.5 (0.2)	37.9 (0.2)	37.9 (0.1)	43.3 (0.3)	43.5 (0.2)	43.7 (0.2)	49.0 (0.4)
Dew Point Temperature (°C)	12.0 (0.8)	14.7 (0.1)	14.4 (0.3)	20.6 (0.1)	12.9 (0.2)	11.9 (0.1)	17.8 (0.1)	7.5 (0.3)	14.8 (0.2)	15.1 (0.2)	17.4 (0.3)
Wet Bulb Temperature (°C)	19.2 (0.3)	20.8 (0.1)	20.6 (0.2)	23.9 (0.1)	21.3 (0.1)	21.0 (0.1)	23.8 (0.0)	20.9 (0.1)	23.8 (0.1)	23.9 (0.1)	26.3 (0.2)
Wet Bulb Depression (°C)	12.9	12.2	12.3	8.4	16.3	17.0	14.1	22.5	19.8	19.8	22.7
Relative Humidity (%)	29.2	33.3	32.8	50.2	23.0	21.1	31.1	11.8	18.9	19.1	16.9
Supply Air Properties											
Dry Bulb Temperature (°C)	19.6 (0.2)	21.5 (0.1)	20.4 (0.2)	23.6 (0.1)	21.7 (0.2)	21.2 (0.2)	23.9 (0.0)	21.0 (0.1)	23.4 (0.1)	24.0 (0.2)	25.3 (0.2)
Dew Point Temperature (°C)	13.0 (0.5)	15.5 (0.1)	14.3 (0.3)	20.5 (0.2)	12.9 (0.2)	11.9 (0.1)	18.5 (0.1)	8.5 (0.4)	15.7 (0.3)	15.9 (0.3)	17.9 (0.3)
Wet Bulb Temperature (°C)	15.5 (0.4)	17.6 (0.1)	16.5 (0.2)	21.4 (0.1)	16.2 (0.1)	15.5 (0.1)	20.2 (0.1)	13.8 (0.2)	18.3 (0.2)	18.7 (0.2)	20.2 (0.2)
Relative Humidity (%)	65.4	68.3	68.2	82.5	57.0	55.1	71.7	44.6	61.8	60.5	63.6
External Resistance (Pa)	**74.7**	**74.7**	**74.7**	**74.7**	**74.7**	**74.7**	**74.7**	**74.7**	**74.7**	**74.7**	**74.7**
Exhaust Air Properties											
Dry Bulb Temperature (°C)	25.0 (0.2)	26.1 (0.1)	25.9 (0.2)	27.1 (0.1)	27.5 (0.1)	27.5 (0.1)	29.2 (0.0)	29.1 (0.1)	30.9 (0.0)	30.9 (0.1)	33.5 (0.1)
Dew Point Temperature (°C)	24.4 (0.1)	25.6 (0.1)	25.4 (0.1)	26.8 (0.0)	27.2 (0.1)	26.9 (0.0)	28.7 (0.0)	28.7 (0.0)	30.3 (0.1)	30.3 (0.1)	32.8 (0.1)
Wet Bulb Temperature (°C)	24.6 (0.1)	25.7 (0.0)	25.5 (0.1)	26.8 (0.0)	27.2 (0.1)	27.1 (0.0)	28.8 (0.0)	28.8 (0.0)	30.4 (0.1)	30.4 (0.1)	32.9 (0.1)
Relative Humidity (%)	96.5	97.2	97.1	98.0	97.8	96.9	97.4	98.0	96.5	96.6	96.0
Power Consumption											
Voltage (V)	240	241	242	239	238	238	241	243	243	242	240
Current (A)	5.7	5.6	5.6	5.7	5.8	5.8	5.7	5.8	5.8	5.8	5.8
Power (W)	1,343 (3.9)	1,334 (3.2)	1,342 (4.4)	1,350 (4.4)	1,359 (4.9)	1,360 (4.2)	1,356 (2.8)	1,383 (4.3)	1,390 (3.2)	1,391 (2.9)	1,377 (3.4)
Power Factor	0.99	0.98	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.99
Fan Speed (RPM)	2,019 (2.4)	2,017 (1.7)	2,025 (2.2)	2,033 (2.3)	2,035 (2.5)	2,038 (2.3)	2,043 (1.4)	2,068 (1.8)	2,075 (1.7)	2,077 (1.6)	2,082 (2.0)
Fan Speed Setting	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
Performance											
Dry Bulb Temperature Drop (℃)	12.5	11.4	12.5	8.7	15.8	16.7	14.0	22.3	20.1	19.7	23.7
Wet-Bulb Effectiveness (%)	97.0	93.7	101.7	103.4	97.1	98.4	99.0	99.3	101.8	99.6	104.5
Dew-Point Effectiveness (%)	51.7	52.7	65.7	76.6	60.7	60.4	60.4	53.3	60.9	59.6	68.0
Supply Airflow Rate (liters/s)	635	641	643	631	631	635	645	629	638	638	632
Room Capacity (kW; 26.7°C reference)	5.33	3.89	4.81	2.28	3.68	4.10	2.09	4.17	2.44	1.97	1.01
Room COP (26.7°C reference)	4.0	2.9	3.6	1.7	2.7	3.0	1.5	3.0	1.8	1.4	0.7
Sensible Cooling of Intake Air (kW)	9.48	8.64	9.54	6.44	11.80	12.59	10.56	16.51	15.06	14.71	17.42
Intake Air COP	7.1	6.5	7.1	4.8	8.7	9.3	7.8	11.9	10.8	10.6	12.7

Table 6: Climate Wizard Test Data (SI Units) – Continued

Test Summary Information	Tests at 37.8°C_{db} / 24°C_{wb}, Maximum Speed, Variable Reistance								
General **[Average (Std. Dev)]**									
Date (2009)	18-Jun	24-Jun	18-Jun	18-Jun	18-Jun	18-Jun	18-Jun	18-Jun	25-Jun
Start Time	2:58p	5:26p	2:29p	3:16p	1:54p	1:40p	3:55p	4:25p	4:10p
Duration (minutes)	15	12	15	8	10	12	10	20	20
Barometric Pressure (kPa)	99.41	99.24	99.43	99.36	99.44	99.45	99.28	99.27	99.59
Inlet Air Properties									
Dry Bulb Temperature (°C)	37.8 (0.1)	37.8 (0.0)	37.8 (0.1)	37.6 (0.0)	37.8 (0.1)	37.9 (0.1)	37.7 (0.1)	37.7 (0.1)	37.7 (1.0)
Dew Point Temperature (°C)	17.8 (0.2)	22.7 (0.1)	17.3 (0.2)	18.1 (0.1)	17.6 (0.1)	17.8 (0.1)	18.7 (0.1)	18.3 (0.2)	11.9 (0.1)
Wet Bulb Temperature (°C)	23.7 (0.1)	26.5 (0.1)	23.5 (0.1)	23.8 (0.0)	23.6 (0.0)	23.8 (0.0)	24.2 (0.1)	24.0 (0.1)	20.9 (0.3)
Wet Bulb Depression (°C)	14.1	11.2	14.4	13.8	14.2	14.1	13.5	13.8	16.8
Relative Humidity (%)	30.9	42.1	30.0	31.8	30.7	31.1	33.0	32.2	21.4
Supply Air Properties									
Dry Bulb Temperature (°C)	24.9 (0.1)	27.1 (0.0)	24.3 (0.1)	24.5 (0.0)	24.2 (0.1)	23.9 (0.0)	23.6 (0.0)	22.8 (0.0)	22.5 (0.2)
Dew Point Temperature (°C)	18.6 (0.2)	22.9 (0.1)	18.0 (0.1)	18.6 (0.1)	18.3 (0.1)	18.5 (0.1)	18.7 (0.1)	18.1 (0.1)	12.3 (0.2)
Wet Bulb Temperature (°C)	20.6 (0.1)	24.0 (0.1)	20.0 (0.1)	20.4 (0.1)	20.2 (0.1)	20.2 (0.1)	20.3 (0.0)	19.6 (0.1)	16.2 (0.1)
Relative Humidity (%)	68.2	77.9	68.0	69.9	69.7	71.7	73.9	74.7	52.5
External Resistance (Pa)	**0.0**	**0.0**	**24.9**	**37.4**	**49.8**	**74.7**	**124.5**	**186.8**	**0.0**
Exhaust Air Properties									
Dry Bulb Temperature (°C)	30.4 (0.1)	31.5 (0.0)	29.9 (0.0)	29.7 (0.0)	29.6 (0.0)	29.2 (0.0)	28.5 (0.0)	27.4 (0.0)	29.0 (0.3)
Dew Point Temperature (°C)	29.7 (0.0)	30.9 (0.0)	29.2 (0.1)	29.3 (0.1)	29.0 (0.1)	28.7 (0.0)	28.2 (0.0)	27.3 (0.0)	28.5 (0.1)
Wet Bulb Temperature (°C)	29.9 (0.0)	31.0 (0.0)	29.4 (0.1)	29.4 (0.1)	29.1 (0.1)	28.8 (0.0)	28.2 (0.0)	27.3 (0.0)	28.6 (0.1)
Relative Humidity (%)	96.4	96.7	96.5	97.4	96.9	97.4	98.2	99.0	97.0
Power Consumption									
Voltage (V)	241	243	241	241	241	241	241	240	238
Current (A)	5.7	5.6	5.7	5.7	5.7	5.7	5.7	5.8	5.8
Power (W)	1,349 (5.1)	1,345 (6.0)	1,351 (4.6)	1,352 (4.1)	1,354 (3.6)	1,356 (2.8)	1,360 (2.8)	1,369 (4.0)	1,352 (4.0)
Power Factor	0.99	0.98	0.99	0.99	0.98	0.99	0.99	0.99	0.99
Fan Speed (RPM)	2,031 (2.2)	2,029 (2.8)	2,033 (2.1)	2,036 (1.9)	2,038 (1.7)	2,043 (1.4)	2,052 (1.3)	2,068 (1.9)	2,025 (4.0)
Fan Speed Setting	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
Performance									
Dry Bulb Temperature Drop (°C)	13.0	10.7	13.5	13.2	13.6	14.0	14.1	15.0	15.2
Wet-Bulb Effectiveness (%)	91.8	95.2	93.9	95.4	95.9	99.0	104.0	108.7	90.3
Dew-Point Effectiveness (%)	52.8	65.6	55.4	58.7	57.4	60.4	71.6	77.8	52.6
Supply Airflow Rate (liters/s)	764	764	722	702	685	645	560	461	756
Room Capacity (kW; 26.7°C reference)	1.60	-0.37	1.97	1.82	1.96	2.09	1.99	2.10	3.69
Room COP (26.7°C reference)	1.2	-0.3	1.5	1.3	1.4	1.5	1.5	1.5	2.7
Sensible Cooling of Intake Air (kW)	11.59	9.49	11.42	10.83	10.93	10.56	9.24	8.12	13.56
Intake Air COP	8.6	7.1	8.5	8.0	8.1	7.8	6.8	5.9	10.0

Table 6: Climate Wizard Test Data (SI Units) – Continued

Test Summary Information	Tests at 37.8°C$_{db}$ / 21°C$_{wb}$, Variable Speed and Resistance									
General [Average (Std. Dev)]										
Date (2009)	26-Jun	26-Jun	25-Jun	26-Jun	25-Jun	25-Jun	26-Jun	26-Jun	26-Jun	2-Jul
Start Time	1:40p	2:03p	3:29p	12:53p	2:48p	4:46p	11:31a	10:54a	11:19a	3:12p
Duration (minutes)	9	15	20	15	20	15	15	12	7	25
Barometric Pressure (kPa)	99.67	99.65	99.62	99.69	99.64	99.59	99.75	99.76	99.75	99.29
Inlet Air Properties										
Dry Bulb Temperature (°C)	37.9 (0.5)	37.8 (0.3)	37.9 (0.8)	37.3 (0.2)	37.5 (0.2)	37.5 (0.7)	37.9 (0.3)	37.8 (0.3)	38.0 (0.2)	37.8 (0.2)
Dew Point Temperature (°C)	12.3 (0.1)	12.4 (0.1)	12.4 (0.2)	11.8 (0.1)	12.9 (0.2)	12.0 (0.1)	11.5 (0.2)	11.9 (0.1)	12.2 (0.1)	13.0 (0.2)
Wet Bulb Temperature (°C)	21.1 (0.2)	21.1 (0.1)	21.2 (0.2)	20.7 (0.1)	21.3 (0.1)	20.9 (0.2)	20.8 (0.1)	20.9 (0.1)	21.1 (0.1)	21.4 (0.1)
Wet Bulb Depression (°C)	16.8	16.7	16.8	16.5	16.3	16.7	17.1	16.9	16.9	16.4
Relative Humidity (%)	21.7	21.9	21.8	21.8	23.0	21.7	20.7	21.2	21.4	22.9
Supply Air Properties										
Dry Bulb Temperature (°C)	22.7 (0.2)	22.4 (0.0)	22.1 (0.1)	21.8 (0.2)	21.7 (0.2)	20.4 (0.1)	20.5 (0.2)	19.9 (0.1)	19.9 (0.1)	20.0 (0.1)
Dew Point Temperature (°C)	12.4 (0.1)	12.5 (0.1)	12.6 (0.2)	11.9 (0.1)	12.9 (0.2)	12.1 (0.2)	11.5 (0.2)	11.7 (0.1)	11.9 (0.1)	13.9 (0.3)
Wet Bulb Temperature (°C)	16.3 (0.1)	16.2 (0.1)	16.2 (0.1)	15.7 (0.1)	16.2 (0.1)	15.3 (0.1)	15.0 (0.1)	14.9 (0.1)	15.0 (0.0)	16.1 (0.2)
Relative Humidity (%)	52.3	53.3	55.0	53.5	57.0	59.0	56.2	59.2	60.0	67.7
External Resistance (Pa)	**0.0**	**0.0**	**37.4**	**37.4**	**74.7**	**124.5**	**124.5**	**174.4**	**174.4**	**186.8**
Exhaust Air Properties										
Dry Bulb Temperature (°C)	29.0 (0.2)	29.0 (0.1)	28.4 (0.2)	27.9 (0.1)	27.5 (0.1)	26.4 (0.1)	26.5 (0.2)	25.6 (0.1)	25.7 (0.1)	26.0 (0.1)
Dew Point Temperature (°C)	28.2 (0.2)	28.3 (0.1)	27.9 (0.2)	27.4 (0.1)	27.2 (0.1)	26.2 (0.1)	26.0 (0.1)	25.1 (0.1)	25.4 (0.0)	25.7 (0.1)
Wet Bulb Temperature (°C)	28.4 (0.1)	28.5 (0.0)	28.0 (0.2)	27.5 (0.1)	27.2 (0.1)	26.2 (0.1)	26.1 (0.1)	25.2 (0.1)	25.5 (0.0)	25.8 (0.1)
Relative Humidity (%)	95.9	96.0	97.2	97.1	97.8	98.4	96.9	97.3	98.3	98.5
Power Consumption										
Voltage (V)	241	241	239	239	238	238	239	237	238	240
Current (A)	5.7	5.7	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.7
Power (W)	1,353 (3.2)	1,352 (5.9)	1,356 (4.7)	1,356 (4.5)	1,359 (4.9)	1,364 (3.2)	1,364 (2.8)	1,364 (3.2)	1,369 (5.2)	1,352 (4.1)
Power Factor	0.99	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98
Fan Speed (RPM)	2,027 (2.3)	2,027 (2.6)	2,030 (3.1)	2,030 (2.4)	2,035 (2.5)	2,047 (3.3)	2,046 (1.9)	2,054 (1.8)	2,059 (2.4)	2,059 (2.4)
Fan Speed Setting	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
Performance										
Dry Bulb Temperature Drop (°C)	15.2	15.4	15.9	15.5	15.8	17.2	17.4	17.9	18.1	17.8
Wet-Bulb Effectiveness (%)	90.8	92.2	94.6	93.8	97.1	103.0	101.7	106.1	107.0	108.3
Dew-Point Effectiveness (%)	55.0	56.1	57.1	56.7	60.7	63.1	62.4	66.5	68.0	62.6
Supply Airflow Rate (liters/s)	756	759	694	697	631	552	553	472	478	441
Room Capacity (kW; 26.7°C reference)	3.54	3.78	3.76	4.05	3.68	4.13	4.07	3.83	3.85	3.49
Room COP (26.7°C reference)	2.6	2.8	2.8	3.0	2.7	3.0	3.0	2.8	2.8	2.6
Sensible Cooling of Intake Air (kW)	13.60	13.78	13.03	12.81	11.80	11.28	11.46	10.13	10.31	9.31
Intake Air COP	10.1	10.2	9.6	9.4	8.7	8.3	8.4	7.4	7.5	6.9

Table 6: Climate Wizard Test Data (SI Units) – Continued

Test Summary Information	Tests at 37.8°C$_{db}$ / 21°C$_{wb}$, Variable Speed and Resistance										
General **[Average (Std. Dev)]**											
Date (2009)	26-Jun	26-Jun	26-Jun	26-Jun	26-Jun	2-Jul	2-Jul	2-Jul	2-Jul	2-Jul	2-Jul
Start Time	2:21p	2:45p	3:03p	3:30p	4:06p	2:31p	10:30a	11:11a	12:31p	1:11p	1:51p
Duration (minutes)	8	15	7	20	25	25	25	25	25	25	25
Barometric Pressure (kPa)	99.62	99.56	99.54	99.53	99.50	99.30	99.34	99.36	99.34	99.33	99.32
Inlet Air Properties											
Dry Bulb Temperature (°C)	37.9 (0.3)	37.8 (0.3)	37.8 (0.3)	37.6 (0.2)	37.6 (0.3)	37.7 (0.2)	37.9 (0.2)	37.9 (0.2)	37.8 (0.2)	37.8 (0.2)	37.8 (0.2)
Dew Point Temperature (°C)	12.2 (0.2)	12.3 (0.2)	12.5 (0.1)	12.5 (0.1)	13.0 (0.2)	12.6 (0.1)	11.7 (0.1)	12.2 (0.2)	12.6 (0.1)	12.2 (0.2)	12.8 (0.2)
Wet Bulb Temperature (°C)	21.1 (0.1)	21.1 (0.1)	21.1 (0.1)	21.1 (0.1)	21.3 (0.1)	21.2 (0.1)	20.9 (0.1)	21.1 (0.1)	21.2 (0.1)	21.0 (0.1)	21.3 (0.1)
Wet Bulb Depression (°C)	16.8	16.7	16.6	16.5	16.3	16.6	17.0	16.8	16.6	16.8	16.5
Relative Humidity (%)	21.5	21.7	22.1	22.3	23.0	22.3	20.9	21.6	22.3	21.6	22.6
Supply Air Properties											
Dry Bulb Temperature (°C)	22.6 (0.1)	21.6 (0.0)	21.3 (0.1)	20.4 (0.2)	20.1 (0.2)	19.5 (0.1)	22.1 (0.1)	21.4 (0.0)	20.8 (0.1)	19.8 (0.1)	19.3 (0.1)
Dew Point Temperature (°C)	12.3 (0.1)	12.3 (0.1)	12.4 (0.1)	12.3 (0.1)	12.6 (0.1)	13.4 (0.1)	13.6 (0.3)	14.0 (0.2)	14.1 (0.2)	13.4 (0.2)	13.5 (0.2)
Wet Bulb Temperature (°C)	16.2 (0.1)	15.9 (0.1)	15.8 (0.1)	15.4 (0.1)	15.5 (0.2)	15.7 (0.1)	16.7 (0.2)	16.7 (0.1)	16.5 (0.1)	15.8 (0.1)	15.7 (0.1)
Relative Humidity (%)	52.1	55.6	56.7	59.5	62.2	68.0	58.5	62.6	65.5	66.7	69.2
External Resistance (Pa)	**0.0**	**37.4**	**74.7**	**124.5**	**174.4**	**186.8**	**0.0**	**37.4**	**74.7**	**124.5**	**186.8**
Exhaust Air Properties											
Dry Bulb Temperature (°C)	29.0 (0.1)	28.2 (0.1)	27.5 (0.1)	26.4 (0.1)	25.6 (0.2)	25.6 (0.1)	29.2 (0.0)	28.4 (0.0)	27.6 (0.1)	26.4 (0.1)	25.1 (0.1)
Dew Point Temperature (°C)	28.3 (0.0)	27.6 (0.0)	27.1 (0.0)	26.0 (0.0)	25.4 (0.1)	25.3 (0.1)	28.1 (0.1)	27.6 (0.0)	26.8 (0.0)	26.0 (0.1)	24.9 (0.1)
Wet Bulb Temperature (°C)	28.5 (0.0)	27.8 (0.0)	27.2 (0.0)	26.1 (0.0)	25.5 (0.1)	25.4 (0.0)	28.4 (0.0)	27.8 (0.0)	27.0 (0.0)	26.1 (0.0)	24.9 (0.1)
Relative Humidity (%)	96.1	96.7	98.0	97.9	98.9	98.3	93.9	95.3	95.8	98.0	98.8
Power Consumption											
Voltage (V)	241	241	241	241	242	240	238	238	239	239	241
Current (A)	5.2	5.2	5.2	5.3	5.2	5.2	4.2	4.3	4.3	4.3	4.2
Power (W)	1,237 (3.1)	1,236 (4.4)	1,241 (3.9)	1,244 (3.0)	1,224 (2.9)	1,232 (3.3)	992 (2.4)	995 (2.7)	999 (2.9)	1,004 (2.9)	988 (2.7)
Power Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Fan Speed (RPM)	1,964 (2.0)	1,969 (2.6)	1,977 (2.4)	1,986 (1.9)	1,986 (2.2)	1,997 (1.9)	1,821 (1.6)	1,828 (1.7)	1,836 (1.6)	1,849 (1.9)	1,854 (1.8)
Fan Speed Setting	**8**	**8**	**8**	**8**	**8**	**8**	**6**	**6**	**6**	**6**	**6**
Performance											
Dry Bulb Temperature Drop (°C)	15.3	16.2	16.5	17.2	17.6	18.2	15.8	16.5	17.0	18.1	18.4
Wet-Bulb Effectiveness (%)	91.1	97.0	99.2	104.1	107.6	110.1	92.7	97.8	102.7	107.7	112.0
Dew-Point Effectiveness (%)	55.2	59.5	62.2	66.0	70.1	63.6	45.6	49.3	54.8	59.8	66.1
Supply Airflow Rate (liters/s)	732	669	604	522	434	409	679	605	534	446	327
Room Capacity (kW; 26.7°C reference)	3.53	4.02	3.86	3.87	3.40	3.48	3.66	3.76	3.74	3.67	2.86
Room COP (26.7°C reference)	2.9	3.3	3.1	3.1	2.8	2.8	3.7	3.8	3.7	3.7	2.9
Sensible Cooling of Intake Air (kW)	13.23	12.85	11.81	10.66	9.05	8.88	12.64	11.77	10.75	9.60	7.18
Intake Air COP	10.7	10.4	9.5	8.6	7.4	7.2	12.7	11.8	10.8	9.6	7.3

Table 6: Climate Wizard Test Data (SI Units) – Continued

Test Summary Information	Tests at 37.8°C_{db} / 21°C_{wb}, Variable Speed and Resistance											
General **[Average (Std. Dev)]**												
Date (2009)	8-Jul	8-Jul	8-Jul	2-Jul	2-Jul	8-Jul	10-Jul	10-Jul	10-Jul	9-Jul	10-Jul	10-Jul
Start Time	3:41p	3:01p	2:25p	4:38p	4:03p	4:21p	10:48a	8:53a	8:09a	11:21a	10:05a	9:32a
Duration (minutes)	25	25	20	20	14	25	20	20	25	20	25	20
Barometric Pressure (kPa)	99.44	99.46	99.48	99.27	99.26	99.41	99.95	99.89	99.93	99.73	99.97	99.96
Inlet Air Properties												
Dry Bulb Temperature (°C)	37.8 (0.4)	37.9 (0.3)	37.9 (0.2)	37.7 (0.2)	37.9 (0.2)	37.9 (0.5)	37.8 (0.2)	37.9 (0.1)	37.8 (0.1)	37.8 (0.1)	37.8 (0.1)	37.6 (0.6)
Dew Point Temperature (°C)	12.3 (0.2)	12.4 (0.1)	12.1 (0.2)	12.3 (0.1)	11.8 (0.1)	12.2 (0.2)	12.8 (0.1)	13.0 (0.0)	13.0 (0.1)	12.5 (0.0)	12.4 (0.1)	12.3 (0.1)
Wet Bulb Temperature (°C)	21.1 (0.1)	21.2 (0.1)	21.0 (0.1)	21.1 (0.1)	20.9 (0.1)	21.1 (0.2)	21.3 (0.1)	21.4 (0.0)	21.4 (0.0)	21.2 (0.0)	21.1 (0.0)	21.0 (0.2)
Wet Bulb Depression (°C)	16.7	16.7	16.9	16.7	17.0	16.9	16.5	16.4	16.4	16.6	16.7	16.6
Relative Humidity (%)	21.9	21.9	21.4	21.9	21.1	21.5	22.6	22.8	22.8	22.1	21.9	22.0
Supply Air Properties												
Dry Bulb Temperature (°C)	22.6 (0.1)	21.6 (0.1)	20.7 (0.1)	19.3 (0.0)	18.8 (0.1)	22.2 (0.1)	20.8 (0.1)	19.8 (0.1)	19.9 (0.1)	22.1 (0.1)	20.2 (0.2)	20.1 (0.1)
Dew Point Temperature (°C)	14.2 (0.2)	14.2 (0.2)	13.7 (0.2)	13.0 (0.1)	12.5 (0.1)	13.5 (0.2)	14.0 (0.1)	13.9 (0.1)	13.9 (0.1)	13.4 (0.1)	13.4 (0.1)	13.2 (0.1)
Wet Bulb Temperature (°C)	17.2 (0.2)	16.9 (0.1)	16.3 (0.1)	15.4 (0.1)	14.9 (0.1)	16.7 (0.1)	16.5 (0.1)	16.1 (0.1)	16.1 (0.1)	16.6 (0.1)	15.9 (0.1)	15.8 (0.0)
Relative Humidity (%)	59.0	62.7	64.4	67.1	66.8	57.9	64.8	68.9	68.4	57.5	65.2	64.4
External Resistance (Pa)	**0.0**	**37.4**	**74.7**	**124.5**	**186.8**	**0.0**	**37.3**	**74.7**	**119.4**	**0.0**	**37.3**	**66.9**
Exhaust Air Properties												
Dry Bulb Temperature (°C)	29.5 (0.1)	28.3 (0.1)	27.2 (0.1)	25.5 (0.1)	23.8 (0.1)	30.0 (0.1)	27.6 (0.1)	25.5 (0.1)	23.3 (0.1)	31.1 (0.0)	26.7 (0.2)	23.1 (0.1)
Dew Point Temperature (°C)	28.3 (0.1)	27.4 (0.2)	26.4 (0.1)	25.0 (0.1)	23.7 (0.1)	25.9 (0.4)	25.3 (0.3)	24.4 (0.0)	22.7 (0.0)	22.4 (0.3)	21.6 (0.4)	21.2 (0.2)
Wet Bulb Temperature (°C)	28.6 (0.1)	27.6 (0.1)	26.6 (0.0)	25.2 (0.1)	23.8 (0.1)	26.9 (0.3)	25.9 (0.2)	24.7 (0.0)	22.8 (0.0)	24.7 (0.2)	23.0 (0.2)	21.8 (0.2)
Relative Humidity (%)	93.6	94.8	95.4	97.2	99.4	78.8	87.2	93.7	96.3	59.9	74.0	89.2
Power Consumption												
Voltage (V)	240	240	240	242	242	240	239	238	238	239	238	238
Current (A)	3.3	3.2	3.2	3.2	3.2	1.5	1.5	1.5	1.5	0.7	0.7	0.8
Power (W)	770 (2.3)	750 (3.2)	756 (2.2)	761 (3.0)	750 (1.9)	340 (2.8)	338 (0.9)	330 (0.6)	334 (1.1)	164 (0.9)	163 (0.5)	166 (0.3)
Power Factor	0.98	0.98	0.98	0.97	0.97	0.95	0.96	0.96	0.96	0.93	0.93	0.93
Fan Speed (RPM)	1,660 (2.4)	1,648 (2.9)	1,658 (1.8)	1,677 (2.4)	1,690 (1.6)	1,212 (4.2)	1,218 (1.0)	1,215 (1.0)	1,242 (2.2)	880 (0.6)	893 (1.1)	915 (1.5)
Fan Speed Setting	**4**	**4**	**4**	**4**	**4**	**2**	**2**	**2**	**2**	**1**	**1**	**1**
Performance												
Dry Bulb Temperature Drop (°C)	15.2	16.2	17.2	18.5	19.1	15.8	17.0	18.1	17.9	15.6	17.7	17.5
Wet-Bulb Effectiveness (%)	90.8	97.1	102.0	110.8	112.5	93.5	103.0	109.9	109.5	94.1	105.9	105.6
Dew-Point Effectiveness (%)	44.0	48.7	53.1	65.0	66.1	49.5	57.0	63.2	63.4	52.5	59.4	59.9
Supply Airflow Rate (liters/s)	617	533	459	353	216	446	348	238	112	331	198	84
Room Capacity (kW; 26.7°C reference)	2.95	3.16	3.25	3.12	2.04	2.36	2.43	1.96	0.91	1.77	1.54	0.66
Room COP (26.7°C reference)	3.8	4.2	4.3	4.1	2.7	6.9	7.2	5.9	2.7	10.8	9.4	4.0
Sensible Cooling of Intake Air (kW)	11.03	10.22	9.37	7.77	4.92	8.30	7.04	5.14	2.40	6.11	4.18	1.74
Intake Air COP	14.3	13.6	12.4	10.2	6.6	24.4	20.8	15.6	7.2	37.3	25.6	10.5

Table 6: Climate Wizard Test Data (SI Units) – Continued

Test Summary Information	Short Tests at Zero Resistance and Each Fan Speed									
General **[Average (Std. Dev)]**										
Date (2009)	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul	10-Jul
Start Time	11:22a	11:27a	11:31a	11:36a	11:44a	11:48a	11:53a	11:59a	12:08p	12:13p
Duration (minutes)	4	4	5	8	3	4	5	9	4	4
Barometric Pressure (kPa)	99.95	99.95	99.95	99.94	99.94	99.93	99.92	99.92	99.92	99.91
Inlet Air Properties										
Dry Bulb Temperature (°C)	38.0 (0.2)	37.6 (0.1)	37.7 (0.2)	37.8 (0.3)	38.1 (0.2)	37.7 (0.2)	38.0 (0.1)	37.7 (0.3)	37.7 (0.2)	37.8 (0.2)
Dew Point Temperature (°C)	11.9 (0.1)	12.4 (0.2)	12.8 (0.2)	13.2 (0.1)	13.1 (0.0)	13.2 (0.0)	13.0 (0.0)	13.4 (0.1)	13.3 (0.1)	13.3 (0.1)
Wet Bulb Temperature (°C)	21.0 (0.0)	21.1 (0.1)	21.3 (0.1)	21.5 (0.1)	21.5 (0.0)	21.4 (0.1)	21.5 (0.0)	21.6 (0.1)	21.5 (0.0)	21.6 (0.1)
Wet Bulb Depression (°C)	17.0	16.5	16.4	16.3	16.5	16.2	16.5	16.2	16.2	16.3
Relative Humidity (%)	21.0	22.2	22.7	23.1	22.7	23.2	22.7	23.5	23.4	23.3
Supply Air Properties										
Dry Bulb Temperature (°C)	22.9 (0.0)	22.8 (0.1)	22.8 (0.0)	22.7 (0.1)	22.6 (0.0)	22.6 (0.0)	22.6 (0.0)	22.7 (0.1)	22.7 (0.1)	22.8 (0.0)
Dew Point Temperature (°C)	13.4 (0.1)	13.9 (0.1)	14.3 (0.2)	14.9 (0.2)	14.7 (0.1)	14.8 (0.1)	14.8 (0.1)	15.2 (0.2)	14.9 (0.2)	15.0 (0.2)
Wet Bulb Temperature (°C)	16.9 (0.0)	17.1 (0.1)	17.4 (0.1)	17.7 (0.1)	17.5 (0.1)	17.6 (0.1)	17.5 (0.1)	17.8 (0.1)	17.7 (0.1)	17.7 (0.1)
Relative Humidity (%)	55.1	56.9	58.9	61.1	61.2	61.5	61.4	62.5	61.7	61.5
External Resistance (Pa)	**0.0**	**0.0**	**0.2**	**0.0**	**0.0**	**0.2**	**0.0**	**0.0**	**0.0**	**0.0**
Exhaust Air Properties										
Dry Bulb Temperature (°C)	31.3 (0.1)	30.4 (0.2)	29.7 (0.1)	29.4 (0.1)	29.5 (0.0)	29.4 (0.0)	29.5 (0.1)	29.5 (0.1)	29.5 (0.1)	29.6 (0.1)
Dew Point Temperature (°C)	19.5 (0.6)	23.9 (0.8)	26.7 (0.7)	27.2 (0.2)	27.4 (0.2)	27.8 (0.1)	28.1 (0.1)	28.3 (0.1)	28.5 (0.0)	28.7 (0.5)
Wet Bulb Temperature (°C)	22.9 (0.4)	25.5 (0.5)	27.4 (0.5)	27.7 (0.1)	27.9 (0.1)	28.2 (0.0)	28.4 (0.1)	28.6 (0.1)	28.7 (0.0)	28.9 (0.3)
Relative Humidity (%)	49.5	68.3	84.0	87.7	88.9	91.2	92.1	93.2	94.1	95.1
Power Consumption										
Voltage (V)	239	238	238	238	238	238	238	238	237	238
Current (A)	0.8	1.5	2.4	3.2	3.7	4.2	4.7	5.2	5.5	5.7
Power (W)	169 (1.3)	332 (0.7)	553 (3.0)	747 (3.4)	866 (2.9)	988 (3.5)	1,101 (3.6)	1,221 (5.6)	1,284 (3.2)	1,347 (5.1)
Power Factor	0.93	0.96	0.97	0.98	0.98	0.98	0.98	0.99	0.99	0.99
Fan Speed (RPM)	895 (0.8)	1,200 (1.4)	1,467 (2.9)	1,644 (2.8)	1,736 (1.5)	1,819 (2.2)	1,892 (2.4)	1,960 (3.5)	1,994 (2.3)	2,028 (3.1)
Fan Speed Setting	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Performance										
Dry Bulb Temperature Drop (°C)	15.1	14.7	14.9	15.0	15.5	15.1	15.4	15.1	15.0	15.1
Wet-Bulb Effectiveness (%)	88.9	89.2	90.9	92.2	93.6	92.9	93.3	93.1	92.7	92.7
Dew-Point Effectiveness (%)	45.2	45.3	46.4	45.9	47.6	46.7	46.6	46.1	46.5	46.6
Supply Airflow Rate (liters/s)	341	458	556	618	650	680	706	731	745	757
Room Capacity (kW; 26.7°C reference)	1.53	2.08	2.56	2.87	3.14	3.28	3.42	3.44	3.53	3.50
Room COP (26.7°C reference)	9.1	6.3	4.6	3.8	3.6	3.3	3.1	2.8	2.7	2.6
Sensible Cooling of Intake Air (kW)	6.11	8.00	9.83	11.02	11.91	12.14	12.87	13.04	13.22	13.52
Intake Air COP	36.3	24.1	17.8	14.8	13.8	12.3	11.7	10.7	10.3	10.0