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WHOLE-HOUSE MECHANICAL VENTILATION IN A MIXED-HUMID CLIMATE

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Presented to
The Academic Faculty

By

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WHOLE-HOUSE MECHANICAL VENTILATION IN A MIXED-HUMID CLIMATE

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I wish to dedicate this work to my husband, Scott Capps, for his never-ending support of my research and full-time career, and to the many building scientists, designers, engineers and contractors out there grappling with practical and effective mechanical ventilation strategies in mixed-humid climates.

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LIST OF SYMBOLS AND ABBREVIATIONS

ACCA	Air Conditioning Contractors of America
ACH_{50}	Air Changes per Hour at 50 Pascals of Pressure
ACH_{nat}	Air Changes per Hour at a Natural Pressure
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BTU/H	British thermal units per hour
CFIS	Central Fan Integrated Supply
CFM	Cubic Feet per Minute
CFM_{50}	Cubic Feet per Minute at 50 Pascals of Pressure
ECM	Electronically Commutated Motor also know as a Brushless DC Motor
ERV	Energy Recovery Ventilator
EST	Eastern Standard Time
F	Fahrenheit
Hg	Mercury
HRV	Heat Recovery Ventilator
IECC	International Energy and Conservation Code
HVAC	Heating, Ventilation and Air Conditioning
MPH	Miles per Hour
inHg	Inches of Mercury
k	Unit of measurement equal to 1,000
USGBC	U.S. Green Building Council
VOC	Volatile Organic Compound

SUMMARY

As building codes and green building programs require tighter home construction, the need for outdoor air ventilation to improve indoor air quality increases. Major improvements in building envelopes and duct systems have led to decreases in heating and cooling loads causing fewer HVAC system run-time hours, and increasing the probability for air stagnation within homes with poor outdoor air ventilation. ASHRAE Standard 62.2 quantifies the amount of whole-house ventilation required based on the number of occupants and the square footage of conditioned space, but leaves the design of the ventilation system up to the mechanical engineer or HVAC contractor. In 2010, ASHRAE began requiring flow testing for confirmation of outdoor air ventilation rates, yet few municipalities and green building programs have adopted the new standard.

Builders in mixed-humid climates are forced to balance the need for outdoor air ventilation with the upfront costs for mechanical ventilation systems, and the potential for increased humidity loads and energy costs associated with mechanical ventilation strategies. One common solution employed in the southeastern United States involves a central fan integrated supply (CFIS) ventilation system controlled with an air-cycler for minimum run-time to meet ASHRAE Standard 62.2. While this system has been tested and proven to meet design ventilation rates, those tests were often conducted on homes constructed by well trained builders receiving strong oversight from building scientists and the design ventilation rates were not always ASHRAE compliant.

The following report analyzes whether the CFIS ventilation system with air-cycler controller provides ventilation meeting ASHRAE Standard 62.2 when employed by builders with minimal training and support.

1 INTRODUCTION

1.1 Why Homes are Built Tighter Today

Historically little attention was paid to home infiltration rates, as energy was abundant and relatively affordable. High rates of natural infiltration allowed homes to dry out when moisture levels increased and provided uncontrolled outdoor air ventilation. Increased energy prices over the last thirty-plus years and the environmental impact of fossil fuel electricity production have led the demand for reducing energy consumption in homes (ASHRAE, 2007, p. 2). In addition, occupants have come to expect greater comfort in homes (Rudd & Lstiburek, 2008) including consistent air temperatures from room to room, lower relative humidity levels in humid climates, higher relative humidity levels in dry climates, pest free living spaces, and the ability to shut out exterior sounds and pollutants. Chan, Price, Sohn, & Gadgil found that “older homes are leakier than newer homes” when analyzing over 70,000 measurements of homes across the U. S. (2003, p. 32).

The 2009 International Energy and Conservation Code (IECC) states, “The *building thermal envelope* shall be durably sealed to limit infiltration”, followed by a list of items to be, “caulked, gasketed, weatherstripped or otherwise sealed with an air barrier material, suitable film or solid material” (International Code Council [ICC], 2009, p. 29). The first and last items on the list are worth noting, “1. All joints, seams and penetrations…12. Other sources of infiltration” (ICC, 2009, p. 29-30), as when interpreted literally, these items would effectively require new homes to be substantially air tight and easily result in homes with less than five air changes per hour when tested with a blower door at a pressure of fifty Pascals (ACH_{50}). The 2009 IECC also states, "All ducts, air handlers, filter boxes and building cavities used as ducts shall be sealed", and requires sealing confirmation through duct leakage testing if the air handler or any ducts are located outside of conditioned space (ICC, 2009, p. 30-31). The duct leakage tested must be less than eight percent leakage to outdoors or twelve percent total leakage based on the floor area served by the duct system (ICC, 2009, p. 31).

The 2009 Georgia State Supplements and Amendments to the IECC removes the option for visual air sealing inspections as a pathway for compliance on single-family residences and instead requires homes be diagnostically tested with confirmed air infiltration less than seven ACH_{50} (Georgia Department of Community Affairs [DCA], 2009, p. 10-11). Energy efficiency and green building programs require and/or award points to homes exceeding code infiltration maximums often resulting in homes with less than five ACH_{50}.

In addition to saving energy costs by keeping conditioned air within the home, air sealing also reduces unwanted air infiltration from vented crawlspaces, garages, attics and the outdoors where uncontrolled sources of pollutants such as mold, moisture, carbon monoxide, insulation fibers, rodent scant, pollen and noise may be concentrated. These pollutants are often a trigger of allergies for occupants if allowed into the home.

1.2 Why Tight Homes Need Ventilation

According to the U.S. Environmental Protection Agency (EPA), “an average adult breathes over 3,000 gallons of air every day,” and “children breathe even more air per pound of body weight” (U.S. Environmental Protection Agency [EPA], 2011). Building science expert Gord Cooke presents similar information in the following manner: people eat about two pounds of food, drink about six pounds of water and breathe about sixty-six pounds of air each day; many people are able to choose what they eat and drink, but not what they breathe (Cooke, 2011).

While it is advantageous for energy, comfort, durability and health to tightly seal homes, effective air sealing can also lead to increased interior pollutants when outdoor ventilation air is not supplied to the occupants. Many building products, interior finishes and furnishings contain high levels of volatile organic compounds (VOC) that off-gas toxins overtime. Consumer cleaning products and household pesticides often contain chemicals toxic to humans under high concentrations. Occupant activities such as breathing, bathing, cooking, exercising, burning candles/incense and smoking, and combustion equipment often found in homes such as fireplaces, gas stoves, furnaces and gas water heaters create by-products including odors, moisture, carbon dioxide, carbon monoxide and other gases that are harmful and often trigger ailments, asthma and other respiratory illnesses among occupants (Wray, Matson, & Sherman, 2000, p. 2; U.S. EPA, 2009). The EPA estimates indoor air pollutant levels may be two to five times higher than outdoor levels and that average Americans spend 90% of their time indoors (U.S. EPA, 2009), making indoor air quality the “fourth-largest environmental threat to our country" (American Society of Heating, Refrigerating and Air-Conditioning Engineers [ASHRAE], 2007, p. 2).

Properly vented combustion appliances, spot and whole-house mechanical ventilation systems remove and dilute indoor air pollutants to reduce occupant exposure at high concentrations over sustained periods of time. The American Society of Heating, Refrigerating and Air-Conditioning Engineers has focused on ventilation for over 100 years and currently sets the American National Standard for residential ventilation, *ASHRAE Standard 62.2: Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*. ASHRAE Standard 62.2 calls for whole-house mechanical ventilation in all homes.[1] While few jurisdictions have adopted ASHRAE Standard 62.2 into local building codes, many green building programs (e.g. LEED for Homes and EarthCraft) and governmental energy efficiency and air quality programs (e.g. ENERGY STAR New Homes, Building America Builders Challenge, Indoor airPLUS) do reference the standard and require it be met for new construction and renovation projects.

1.3 Research Objectives

While the need for whole-house mechanical ventilation has been well documented (ASHRAE, 2007; Rudd, Lstiburek, Eng, & Townsend, 2009)) and a national standard

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[1] ASHRAE Standard 62.2 does allow the following exceptions for mechanical ventilation when, "at least one of the following conditions is met: a. the building is in zone 3B or 3C of the IECC 2004 Climate Zone Map [neither zones are present in the Southeast], b. the building has no mechanical cooling and is in zone 1 or 2 of the IECC 2004 Climate Zone Map, or c. the building is thermally conditioned for human occupancy for less than 876 hours per year, *and* if the authority having jurisdiction determines that window operation is a locally permissible method of providing ventilation.

exists which is referenced by several green building and energy efficiency programs, the question remains whether ventilation systems being installed in new construction residential dwellings with minimal oversight from a building science consultant are meeting the ASHRAE Standard 62.2 for whole-house ventilation. Through testing a sample set of the multifamily units, the following research intends to document whether central fan integrated supply whole-house ventilation systems installed in multifamily dwelling units provide the amount of ventilation specified by ASHRAE Standard 62.2 as required by the green building program being tracked for building certification and as designed by the mechanical engineer for the project. And if the systems do not meet the targeted ventilation rates, propose solutions that may be employed in the field to increase the potential for future installations to meet design criteria.

The research documented on the following pages includes a combination of previously reported field research conducted by leading building scientists, and newly completed field testing of nineteen multifamily dwelling units in the mixed-humid climate of Atlanta, Georgia.

2 LITERATURE REVIEW

2.1 Amount of Ventilation Recommended

ASHRAE Standard 62.2 calls for whole-house ventilation equivalent to seven and a half cubic feet per minute (CFM) per person, with the number of people being the number of bedrooms plus one, unless higher occupant density is known, and one CFM per hundred square feet of conditioned floor area (ASHRAE, 2007, p. 4).[2]

While the level of ventilation required by ASHRAE Standard 62.2 has been considered excessive for homes in humid climates by prominent industry professionals due to the potential for increased indoor humidity levels (Moyer, Chasar, Hoak, & Chandra, 2004), Walker and Sherman (2007) determined, “that although 62.2 compliant ventilation systems increase average indoor humidity in hot humid climates, the number of high humidity events is unchanged. Other factors such as occupant density, climate and air conditioner operation are more significant factors in determining indoor humidity.”

Kovesi et al. (2009) documented reduced reports of respiratory symptoms in Inuit children in homes with heat recovery ventilators (HRV) providing roughly the amount of ventilation specified by ASHRAE Standard 62.2 at fifteen CFM per person (p. 489). And, international studies have suggested higher levels of ventilation closer to half an air change per hour or more may reduce allergies and respiratory illnesses in tight homes (Lajoie, Leclerc, & Schnebelen, 2007, p. 4; Sundell et al, 2011, p. 196).

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[2] ASHRAE 62.2 does make some allowance for an infiltration credit; however that is not addressed within this research.

LEED for Homes, a national green building certification program for low-rise single and multifamily residential dwellings developed by the U.S. Green Building Council (USGBC), references ASHRAE Standard 62.2, with some exceptions for mild climates and passive ventilation systems, as the ventilation requirement for homes (U.S. Green Building Council [USGBC], 2008, p. 90). EarthCraft Multifamily, a southeast regional green building program for low and mid-rise multifamily residential dwellings developed by Southface Energy Institute, also references ASHRAE Standard 62.2 as the ventilation requirement for homes (Southface Energy Institute, 2009). Both programs require infiltration testing with minimum tightness thresholds of roughly one-third of an air change per hour at natural state.

2.2 How Climate Impacts Ventilation Strategies

The U.S. is divided into seven climate zones by the 2009 IECC, each with three potential moisture designations: moist, dry and marine. Building scientists often refer to the U.S. climate zones as hot-dry, mixed-dry, marine, cold, very cold, mixed-humid and hot-humid (The Energy and Environmental Building Alliance [EEBA], 2011). See Appendix A for the 2009 IECC Climate Zone Map and the industry-accepted climate zone map.

Dry, cold and marine climate zones commonly use negative-pressure ventilation strategies, as there is little concern in those areas for moisture condensation in wall cavities when air is being pulled into the home through infiltration since the exterior air is typically at a lower relative humidity than indoor air (Rudd, 2006). Mixed-humid and hot-humid climates tend to use positive-pressure ventilation strategies due to the concern for moisture condensation in wall cavities as the exterior air is commonly at a higher relative humidity than indoor air (Lstiburek, 1993, p. 1). Balanced ventilation strategies, systems that provide equal amounts of positive and negative pressure ventilation, work well in all climates.

Atlanta, Georgia, falls within climate zone 3A and is commonly referred to as a mixed-humid climate with 2,991 average annual heating degree days, 1,667 average annual cooling degree days, 50.8 inches of average annual rainfall and 70.5 average relative humidity (Climate-Zone.com, 2003).

2.3 Types of Whole-House Mechanical Ventilation Strategies and the Pros/Cons of Each with Respect to a Mixed-Humid Climate

Whole-house mechanical ventilation is typically provided in one of three ways, through negative pressure ventilation (exhaust), positive pressure ventilation (supply) or a combination of equal amounts of negative and positive pressure ventilation known as balanced ventilation (Rudd, 2006).

Ventilation systems may run continuously twenty-four hours a day, or intermittently, e.g. thirty-three percent of the time. Continuous ventilation systems may provide some additional benefit by preventing the potential build-up of pollutants that may occur in between intermittent ventilation cycles (Sherman, 2008, p. 4).

2.3.1 Exhaust Ventilation

Negative pressure ventilation exhausts pollutants through one or more centralized fans with make-up air coming from infiltration through the building envelope, or a specified source such as a trickle ventilator (Wray, Matson, & Sherman, 2000, p. 7). Exhaust ventilation is most commonly known by consumers for single point source pollutant removal such as bath fans, kitchen range hoods, clothes dryers or exhaust fans in home workshops. Sometimes multiple bathrooms are connected to a central bath fan known as multipoint exhaust ventilation.

Exhaust ventilation is relatively affordable to install given that the most common strategy used is one or more bath fans set for continuous operation. Operation costs are also low as ENERGY STAR bath fans operate on very low wattage when compared to the wattage of air handlers which commonly distribute ventilation air in positive pressure and balanced ventilation systems (Steven Winter Associates [SWA], 2005, pp. 7-9). However, spot exhaust ventilation has been proven to provide ineffective mixing of fresh air within the home, especially in homes where occupants keep interior doors closed (Sherman & Walker, 2007).[3]

In mixed-humid climates, there is concern for moisture condensation in the wall cavities as warm-humid air is drawn in through cracks and penetrations (Lstiburek, 1993, p. 1); this concern is increased when vapor barriers such as vinyl wall paper and mirrors are installed along the interior of exterior walls (U.S. EPA and U. S. Department of

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[3] Mixing is discouraged for point source pollution to prevent the contamination of additional spaces (Sherman & Walker, 2007). This research is addressing whole-house fresh air ventilation in which case mixing is encouraged for effective distribution throughout the home to all occupant locations.

Energy [DOE], 2011, pp. 15-16). Additional concerns associated with exhaust only ventilation strategies have been documented by Rudd and Lstiburek (2008) including carpet collecting dust along floor boards due to infiltrating air, carbon monoxide and other pollutants being drawn indoors from attached garages, back drafting of combustion appliances, increased dust in homes due to lack of filtration of outdoor air being drawn in through the building envelope, and occupants being annoyed by continuous fan noise in bathrooms (p. 1-238).

2.3.2 Supply Ventilation

Positive pressure ventilation pushes pollutants out of the home through exfiltration of additional supply air. Because the indoor air in mixed-humid climates is typically drier than outdoor air, there is little to no concern for moisture condensation in the wall cavity as the air leaves the building envelope through cracks and penetrations such as dryer, kitchen and bath vents (Lstiburek, 1993; and Russell, Sherman, & Rudd, 2005, p. 11).

Supply ventilation strategies commonly consist of outdoor air supplied to the return side of the HVAC system which is then distributed to the home through the HVAC duct work (Lstiburek, 1993, p. 10); this ventilation strategy is known as the central fan integrated supply (CFIS) system. The outdoor air comes from a known location and is able to be filtered and conditioned by the HVAC system prior to distribution to the occupants. Since the distribution system used reaches all occupied spaces in the home, mixing of the house air is increased, decreasing the potential for pollutant build-up (Sherman & Walker, 2007).

The outdoor air duct leading to the return may have one of several control mechanisms as reviewed by Rudd (2006) and Russell et al. (2005). There may be a flap damper that allows the duct to open every time the thermostat calls for heating or cooling and remain open as long as the air handler blower is running. An electronic damper may be added to determine how long the outside air duct remains open during a given heating or cooling cycle. An air cycler or other controller may also be added to turn on the air handler blower and pull in outdoor air for set periods of time so that the system still operates during swing seasons when little or no heating or cooling is required. A thermidistat and/or humidistat may be included to determine whether the outdoor air duct damper will open under extreme ambient temperatures and humidity levels. Some systems may have an additional dehumidification option for dehumidifying the outdoor air beyond what the air conditioner is capable of prior to the outdoor air reaching the occupants. Other systems may integrate a stand-alone dehumidifier to dehumidify the house air.

The more complex the controls are, the greater flexibility the engineer has with design and the more power the user has over the system, however complex controls may lead to a more confusing system for design, installation, programming and operation. At a minimum, CFIS ventilation systems should incorporate an air cycler to dictate how often the air handler fan pulls in outdoor air and for how long, as studies have shown that not having this control mechanism leads to under ventilation (Offerman, 2010, p. 59; Vieira et al., 2008).

While the up-front cost for basic CFIS ventilation systems with an air cycler controller are very low, the common fan used for pulling in the outdoor air and distributing it to occupants is the blower on the air handler. Therefore there is often a high energy penalty paid for using such a large wattage fan for distributing the outdoor air (Vieira et al., 2008; Rudd & Lstiburek, 2008, p. 1-241; SWA, 2005). This energy penalty for ventilation is increased in highly efficient homes that do not require long run-times for heating and cooling as the air handler runs less often for space conditioning increasing the runtime required for ventilation (Vieira et al, 2008). However, Vieira et al. (2008) found that "the excess power of using the air handler fan [for ventilation] can be somewhat ameliorated by the use of a variable speed fan with a more efficient brushless DC motor."

2.3.3 Balanced Ventilation

Balanced strategies for whole-house ventilation systems provide equal amounts of supply and exhaust air to the home during the same run cycle. Common balanced ventilation strategies incorporate the use of heat recovery ventilators (HRV) or energy recover ventilators (ERV). HRVs and ERVs provide some preconditioning of the incoming air by equalizing the heat (HRV), or heat and moisture (ERV), loads between the exhaust and supply air streams. HRVs are more common in cold climates where incoming air needs to be preheated by exhaust air to prevent cold drafts for occupants (Gord, 2011). ERVs are more common in mixed-humid climates where moisture levels of incoming supply air pose concern for potentially increasing interior moisture loads (Gord, 2011).

ERVs may be installed in a variety of configurations with common installations in mixed-humid climates being either tied into the central duct system of the HVAC unit or being stand-alone units independently ducted (Gord, 2011; Russell et al., 2005). ERVs integrated in with the central duct system may require the air handler fan to be running in order to bring in the design rate CFM due to the static pressures in the duct system and the ERV's fan capacity, and under those circumstances, the energy required for ventilation is increased to be similar to the CFIS systems (SWA, 2005).

Stand-alone units are designed to push air through the duct work distribution system of the ERV and do not require the added fan power of the central air handler. However, some stand-alone units are ducted simply, only pulling air from one or two locations in the home and supplying air to only one or two locations in the home. This simple configuration of duct work can lead to decreased fresh air distribution in the home, especially in homes where occupants keep interior doors closed (Rudd, 1999, p. 1).

Spot ERVs remove and return air to the same location simplifying construction installation by removing distribution duct work. Spot ERVs began taking market hold in the mid to late 2000s with the advent of the Panasonic WhisperComfort™. Providing the benefits of the ERV technology with a sales price of ~$300, spot ERVs offered an affordable alternative to whole-house ventilation. However, the low flow rates of the spot ERV (30-40 CFM) and the spot ventilation location can pose concerns for effective distribution of fresh air throughout the home.

The CFIS ventilation system with air-cycler controller was selected for testing in this study because it is the most commonly deployed ventilation strategy by builders working with the researcher in the mixed-humid climate of Atlanta, GA.

2.4 The Need for Performance Testing of Whole-House Ventilation Systems

Due to the multitude of factors impacting field installations of fresh air ventilation systems, performance testing is critical to ensure effective air flow to occupants. Outdoor air ventilation systems are required under ASHRAE Standard 62.2 – 2010 to be tested to ensure the design air flow is met by the system as installed (ASHRAE, 2010, p. 4). The LEED for Homes and EarthCraft Multifamily programs award points for flow testing on ventilation systems to verify ASHRAE Standard 62.2 ventilation rates are met. ENERGY STAR Qualified New Homes version 3 requires a Home Energy Rating System (HERS) Rater verify ventilation air flows within 100-120 percent of the HVAC contractor design (2011, p. 12). The Air Conditioning Contractors of America (ACCA), an industry association supporting quality standards for contractors, requires confirmation for ventilation system compliance by HVAC contractors under ACCA Standard 9 (2010, p. 16).

3 METHODOLOGY

3.1 Test Project Selection

Given the accessibility of homes in the EarthCraft program and the requirement for EarthCraft homes to have mechanical ventilation in compliance with ASHRAE Standard 62.2, it was decided that an EarthCraft project would be used for this study. Builders and contractors participating in EarthCraft are required to attend some training on building science and the whole-house mechanical ventilation requirements of the program. CFIS ventilation systems coupled with an air cycler set to a duty cycle of twenty to thirty-three percent run-times are the most commonly employed systems by EarthCraft builders and contractors for whole-house ventilation. Exhaust ventilation is not allowed in the program due to the concerns for interstitial moisture condensation and other adverse health impacts for the occupants as described in the literature review section of this report. Thousands of homes have been constructed with CFIS ventilation systems in the EarthCraft program, but relatively few have been tested for ventilation performance.

In order to facilitate testing on multiple homes within a short period of time and to minimize the variables between test homes, an EarthCraft Multifamily project was selected for testing. The test project was selected based on the following criteria: builder cooperation, project information availability, HVAC system configuration and unit accessibility. The builder had to be open to the units being tested and providing detailed project information. The heating and cooling systems had to be consistent in type, e.g. all heat pump units with similar installation, controls and filters. The ventilation system configuration had to include a central fan integrated supply duct with a mechanical damper to control when the ventilation air would be drawn into the unit, and consistent exterior wall caps.

Finally, over twenty homes needed to be available for testing during the week of October 3, 2011, with all systems installed and completed for occupancy. Units were selected based on size and location within the building with a minimum of two units of each unit-type used in the study tested for whole-house outdoor air flow.

In an effort to ensure the research would be able to definitely answer the narrowly defined hypothesis within the time period available for testing, the project selection process followed, the decision to test twenty units and the methodology used for selecting the specific test units were all based on purposive and convenience nonprobailistic sampling methods (Trochim, 2006).

3.2 Test Procedures

Various air flow testing devices are accepted within the residential construction and HVAC industry for testing air flows including flow hoods, hotwire anemometers, rotating vane anemometers and manometers (TSI Incorporated, 2007, pp. 4-13). Whether or not the tester is able to access the outdoor inlet on the CFIS ventilation system determines which testing devices may be used. Hotwire anemometers, rotating vane anemometers and manometers may all be used to test inline air flows when the outdoor air inlet is not accessible.

Hotwire anemometers measure a wide range of velocity by heating a sensor to a specific temperature and measuring the rate at which power is required to be supplied to the sensor to maintain that temperature when the sensor is inserted into an air stream (TSI Incorporated, 2007, p. 6). Given the low flow measurement capabilities of a hotwire anemometer and the accessibility of the instrument to the researcher, a TSI 9535 hotwire anemometer with 0-6,000 feet per minute accuracy range calibrated on June 18, 2009 was selected for testing the CFIS ventilation system air flows.

Based on the ACCA Technician's Guide for Quality Installations (2010) and the log-Tchebycheff method for traversing a round duct to test air flow as described in the Alnor® HVAC Handbook (2007, p. 30-31), each ventilation system was tested using a hotwire anemometer. A single traverse was selected due to the restrictions of the mechanical closets at the test site preventing the space required for a second and third traverse, and the desire to develop a test procedure that would be realistic under common field conditions where time and invasiveness of testing have been large factors in determining the probability of a test being conducted.[4] Though the traverse location should have been three duct diameters upstream and seven and a half diameters downstream from any obstructions or elbows, the mechanical closet did not allow for that spacing. Therefore, the traverse probe location was drilled using a 3/8" drill bit approximately three duct diameters upstream from the mechanical damper, and approximately five duct diameters downstream from an elbow or fire damper depending on the mechanical closet configuration. See Figure 3.1 for an image of a mechanical

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[4] A simple comparison of single vs. double traverse testing was conducted at Southface's Southeast Weatherization Energy Efficiency Training (SWEET) Center and showed no significant differences between the test results when using a single traverse as when using a double traverse.

closet at the test site. Approximate measurements were taken for outdoor air duct length and the number of elbows along each run.

Additional information collected during testing included: external wind speed, barometric pressure, ambient temperature, thermostat set-point and ventilation controls.

Figure 3.1: Typical Mechanical Closet in Test Building

4 FIELD RESULTS

4.1 Test Site Description

Field testing was conducted on October 8, 2011, between 9:00AM and 4:00PM EST in Atlanta, Georgia, with additional field observations on October 17 and 26, 2011. Based on information obtained from Weather Underground (Masters, Steremberg, Ferguson, & Schwerzler, 2011), ambient temperature ranged from 58° F to 76° F, wind speed ranged from 0.0 MPH to 1.3 MPH and barometric pressure ranged from 30.32 in Hg to 30.41 in Hg during the testing period.

The EarthCraft Multifamily test project selected was a wood-framed three-story, forty-unit open-corridor multifamily building with five unit-types. Unit-type A1 was a 1-bedroom unit with 657 square feet of conditioned space. Unit-type A2 was a 1-bedroom unit with 780 square feet of conditioned space. Unit-type B1 was a 2-bedroom unit with 1,076 square feet of conditioned space. Unit-type B2 was a 2-bedroom, 2-story unit with 1,570 square feet of conditioned space. Unit-type C1 was a 3-bedroom unit with 1,406 square feet of conditioned space. See Table 4.1 for number of units in the building by unit-type.

Each unit had a wall-hung heat pump (Rheem® RHBL-High Efficiency X-13), either 24,000 British thermal units per hour (BTU/H) or 36,000 BTU/H in size with dual-speed blower and electronically commutated motor (ECM). The heat pump was located within the conditioned space in a mechanical closet with a louvered door for return-air flow. A five or seven inch hard metal duct with a fire damper, mechanical damper

(ZONEFIRST™ RDS) and manual damper supplied outdoor air directly to the return cabinet of each air handler where a MERV 8 filter (Flanders® Pre-Pleat 40 LPD) was located. Metal wall caps with 1/4" pest screen were located on the exterior of each unit and sized to match the corresponding duct diameter. See Table 4.2 for unit-type heat pump and outdoor air duct sizes. See Figure 4.1 for an image of a metal wall cap on the test building. The fire damper was located at the intersection of the outdoor air duct and ceiling drywall. The mechanical damper was located just before an elbow connected the outdoor air duct to the return. The manual damper was located at the connection of the outdoor air duct to the return. See Figure 3.1 for an image of a typical mechanical closet in the building. Each mechanical system was controlled by a programmable thermostat (Honeywell VisionPro® IAQ). See Figure 4.2 for an image of the thermostat. Every home was equipped with a stand-alone thirty-pint dehumidifier (Zenith ZD300YO), located in the mechanical closet, to remove any excess humidity brought into the home by the CFIS ventilation system.

Table 4.1: Number of Units by Unit-Type in Building

Unit Type	A1	A2	B1	B2	C1
Number of Units	2	6	24	2	6

Table 4.2: Heat Pump and Outdoor Air (OA) Duct Size by Unit-Type in Building

Unit Type	A1	A2	B1	B2	C1
Heat Pump Size (kBTU/H)	24	24	24	36	36
OA Duct Size	5”	5”	7”	7”	7”

Figure 4.1: Metal Wall Cap on Test Building

Figure 4.2: Thermostat Used in Test Building

4.2 Field Testing

Four of the five unit-types were deemed appropriate for testing: A1, A2, B1 and C1. Unit-type B2 was the only multi-story unit-type and included a zoned HVAC system, therefore unit-type B2 was not used as part of the sample data set. See Appendix B for the floor plans of the four unit-types tested. Nineteen units were selected from the six unit-types, based on orientation and location within the building, to achieve a sample of one unit type per floor, except for unit A1 which was only located on the ground floor. Each unit used for the study was tested twice for ventilation air-flow for a total of nineteen units and thirty-eight air flow tests. See Table 4.3 for specific units tested.

Table 4.3: Units Tested by Unit Number and Unit Type

Unit Type	A1	A2	B1		C1
Unit Number	3113	3106	3102	3209	3103
	3114	3108	3107	3210	3201
		3208	3110	3302	3303
		3308	3111	3305	
			3205	3312	

The two ventilation air-flow tests were conducted with the apartment set to normal operating conditions, i.e. the exterior doors and windows closed, interior doors to main rooms open and the mechanical closet louvered door closed. The first ventilation air-flow test was conducted while the system was set to the fan ON position, but no cooling was called for by the thermostat. This test simulated the ten minute duty cycle the system would perform when no space conditioning was required for one-hour or greater. The second ventilation air-flow test was conducted while the system was set to the fan ON position and the thermostat called for cooling. This test simulated the system running during normal cooling or heating conditions. According to the manufacturer air flow performance data sheet and observed installation conditions by the researcher, the fan ON position operated the blower motor at 50% of the motor speed on the lower of the two set motor speeds, and the fan ON position with the thermostat calling for cooling operated the blower motor at the higher of the two set motor speeds (Rheem Heating, Cooling and Water Heating, p. 8).[5]

Due to the configuration of the anemometer probe and small duct diameters of five-inches and seven inches, adjustments were made to the log-Tchebycheff concentric circles as follows. The seven-inch ducts were traversed at the following points: 6(5/8)", 6", 4(11/16)", 3(1/4)", 1(7/8)", and 1(5/16)". The five-inch ducts were traversed at the following points: 4(1/2)", 3(5/8)", 1(7/8)", and 1(5/16)".

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[5] According to the manufacturer specifications sheet (Rheem Heating, Cooling and Water Heating, p. 8) the RHBL-High Efficiency X-13 units have five motor speed taps allowing the systems to perform at two nominal cooling capacities. One and a half and two ton capacities for the smaller unit, and two and a half and three ton capacities for the larger unit. The factory wiring default sets the motors to the highest speed for the highest cooling capacity available. The air flow for the fan ON position when no space conditioning is needed (speed tap one) is set to run the motor at half the air flow speed of the smaller cooling capacity of the unit. Field observation of wiring taps confirmed that the motor wiring was left to factory defaults.

Approximate measurements were taken to estimate the length of duct run and the number of elbows in the outdoor air intake. See Table 4.4 for approximate outdoor air duct length and elbow information by unit number, unit-type and unit location. Elbows were estimated based on the number visually documented within the mechanical closet and the number expected based on the external wall cap location. While the mechanical plans for the units also dictated the number of elbows, the plan drawings were not realistic for field implementation given the open-web floor joist framing used and were therefore ignored for the purposes of this study. See Appendix B for the mechanical plans for the units tested.

Table 4.4: Approximate Outdoor Air (OA) Duct Length and Elbows by Unit Number, Unit-Type and Unit Location

Unit Number	**Unit Type**	**Unit Location**	**Number of Elbows in Mech. Closet**	**Number of Elbows Estimated Outside of Mech. Closet**	**Length of OA Duct in Mech. Closet**	**Approx. Length of OA Duct Outside of Mech. Closet**
3102	B1	1st floor, East	1-90°	2-90°	64"	28'
3103	C1	1st floor, West	2-90°	2-90°	64"	18.5'
3106	A2	1st floor, East	3-90°	2-90°	74.5"	27'
3107	B1	1st floor, West	1-90°	2-90°	64"	21'
3108	A2	1st floor, West	3-90°	2-90°	74.5"	27'
3110	B1	1st floor, West	1-90°	2-90°	64"	28'
3111	B1	1st floor, East	1-90°	2-90°	64"	28'
3113	A1	1st floor, South	1-90°	2-90°	64"	14'
3114	A1	1st floor, South	1-90°	2-90°	64"	14'
3201	C1	2nd floor, East	2-90°	2-90°	64"	18.5'
3205	B1	2nd floor, East	1-90°	2-90°	64"	21'
3208	A2	2nd floor, West	1-90°, 1-45°	2-90°	67"	27'
3209	B1	2nd floor, East	1-90°, 1-45°	2-90°	64"	28'
3210	B1	2nd floor, East	1-90°	2-90°	64"	28'
3302	B1	3rd floor, East	1-90°	2-45°	64"	30'
3303	C1	3rd floor, West	1-90°, 1-45°	2-45°	64"	30'
3305	B1	3rd floor, East	1-90°, 2-45°	2-45°	64"	30'
3308	A2	1st floor, West	1-90°	2-45°	62.5"	30'
3312	B1	3rd floor, West	1-90°	2-45°	64"	30'

4.3 Test Results

According to the mechanical engineer for the test project, the CFIS ventilation system mechanical damper duty cycle was to run twenty minutes every hour for a thirty-three percent duty cycle. Table 4.5 lists the targeted design intermittent ventilation air flow rates by unit. Based on the thermostat installation programming and observation of the ventilation cycle in unit 3110, the ventilation duty cycle when the fan was set to ON and no cooling or heating was called for, was ten minutes per hour or seventeen percent.[6] It was undetermined whether the ventilation cycle ran continuously when the fan was set to AUTO and cooling or heating was called for, since in several units the mechanical ventilation damper only stayed open for ten minutes under this configuration, but in one unit the mechanical ventilation damper remained open for longer than ten minutes when the system was calling for conditioning.

Table 4.5: Target Intermittent Ventilation Air Flow Rates

Unit Type	Ventilation Target in CFM
A1	90
A2	90
B1	135
C1	135

Aside from lock-out temperatures of ≥90° F and ≤0° F, all ventilation control functions on the thermostat were left to manufacturer default settings. In addition, the air handler motors were not field adjusted as called for based on the systems installed. The

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[6] Researcher analyzed installed thermostat wiring and programming using the Honeywell VisionPRO® IAQ Total Home Comfort System product manual (Honeywell, 2006).

Rheem RHBL High Efficiency X-13 heat pumps allowed for two nominal cooling capacity tonnage sizes dependent on the motor speed settings dictated by the motor wiring; one and a half or two tons for the 24,000 BTU/H capacity and two and a half or three tons for the 36,000 BTU/H capacity (Rheem Heating, Cooling and Water Heating, p. 8). The mechanical engineer specified one and a half tons of cooling capacity for unit-types A1 and A2, two tons of cooling capacity for unit-type B1 and two and a half tons of cooling capacity for unit-type C1. Based on the installation observed, all units were installed at default manufacturer settings leaving motor wiring for unit-types A1, A2 and B1 at two tons of cooling capacity and unit type C1 at three tons of cooling capacity. Unit-type B1 had a seven-inch outdoor air duct installed rather than the designed five-inch duct.

In addition, the manual outdoor air flow dampers in five of the nineteen units tested (twenty-six percent) were completely closed. See Figure 4.3 for an example of a closed outdoor air flow damper. Given that the HVAC inspections were completed by the contractor prior to testing, there is a high possibility that the dampers would have been left in this position had the testing not been conducted.

Figure 4.3: Closed Outdoor Air Flow Damper

Despite the field-observed incorrect motor wiring resulting in higher fan speeds than design specified when the system was calling for cooling in units A1, A2 and C1, none of the systems pulled in enough outdoor air to meet the targeted ventilation rates. See Table 4.6 for average ventilation test flow results by unit and test-type for units with seven-inch outdoor air ducts, Table 4.7 for average ventilation test flow results by unit and test-type for units with five-inch outdoor air ducts, and Appendix C for all ventilation test flow results by unit and test-type.

Table 4.6: Average Ventilation Test Flow Results by Unit and Test-Type for Units with Seven-Inch Outdoor Air Ducts in CFM

Unit Number	Unit Type	Avg. Fan ON in CFM	Avg. AC ON in CFM	Increase between Fan and AC in CFM
3110	B1	41	58	17
3111	B1	31	56	25
3107	B1	32	55	23
3102	B1	46	58	11
3103	C1	36	43	6
3205	B1	36	80	43
3210	B1	52	69	17
3209	B1	54	60	6
3201	C1	29	62	33
3303	C1	24	61	37
3302	B1	40	64	24
3312	B1	12	39	27
3305	B1	39	66	27
	Average	37	59	23
	Minimum	12	39	6
	Maximum	54	80	43

Table 4.7: Average Ventilation Test Flow Results by Unit and Test-Type for Units with Five-Inch Outdoor Air Ducts in CFM

Unit Number	Unit Type	Avg. Fan ON in CFM	Avg. AC ON in CFM	Increase between Fan and AC in CFM
3108	A2	13	24	11
3106	A2	22	35	13
3208	A2	10	14	5
3113	A1	13	20	8
3114	A1	2	20	18
	Average	12	23	11
	Minimum	2	14	5
	Maximum	22	35	18

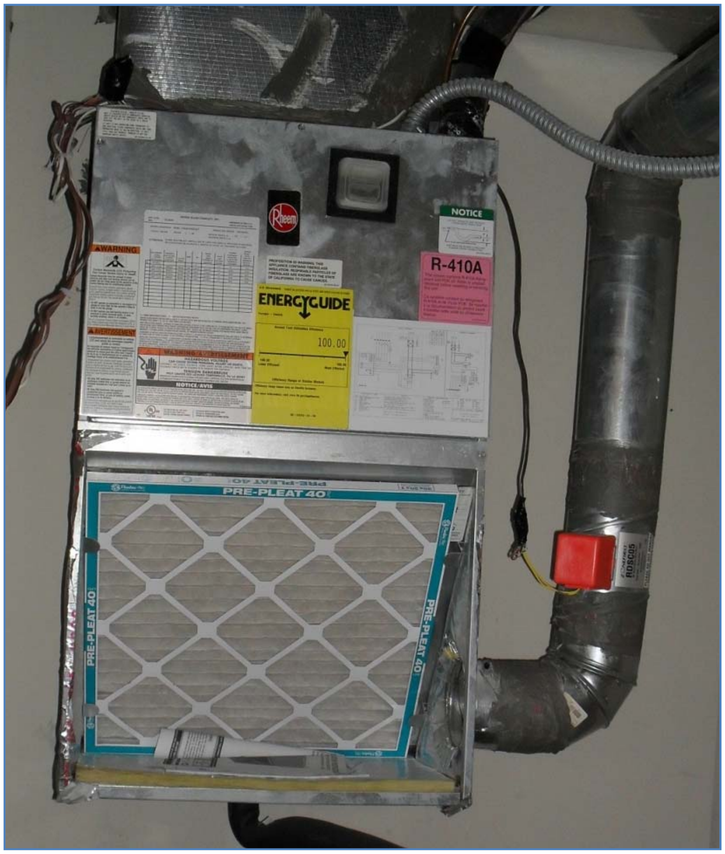
4.4 Results Evaluation

The following air flow obstructions were observed in the outdoor air ducts during testing: misaligned exterior wall caps for outdoor air ducts, fire dampers as required by code and crimps in duct connections. See Figure 4.4 for an example of a misaligned outdoor air intake wall cap and Figure 4.5 for an example of a fire damper and metal duct connection obstruction. Product literature left in the return compartments of the air handlers were pulled against the filter during operation, and though the literature was removed on the units tested, additional literature may remain obstructing return air flow in units not tested. See Figure 4.6 for an example of product literature in the return compartment.

Figure 4.4: Misaligned Wall Cap on Outdoor Air Intake

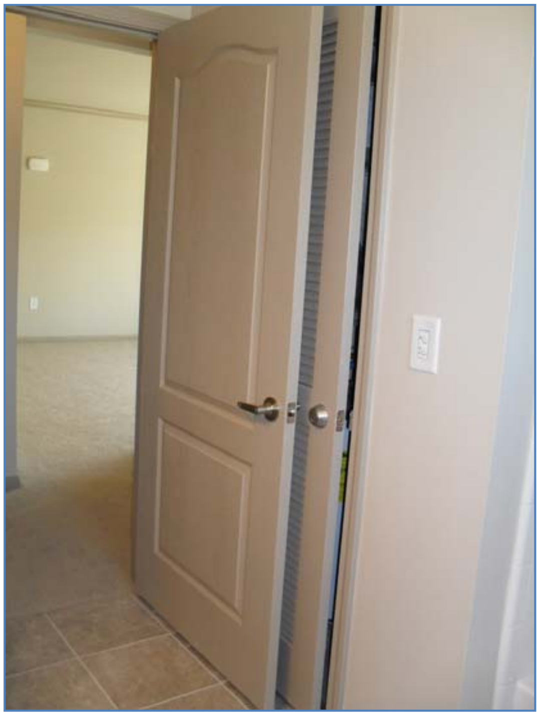
Figure 4.5: Fire Damper and Duct-Connection Restrictions in Outdoor Air Duct

Figure 4.6: Product Literature Left in the Return Compartment



Based on the architectural plans and mechanical design, unit-type C1 was designed to have the mechanical closet open to a hallway connected to the main living area of the apartment similar to all of the other unit-types. See Appendix B for unit-type C1 floor plan denoting mechanical closet layout. However, the closet as constructed opened to the hall bathroom behind the bathroom door. See Figure 4.4 for an image of the C1 mechanical closet and hall bathroom door configuration. A small return opening was cut into the side of the mechanical closet for air to enter in from the hall, but the return opening was clearly less than the size required for proper air flow. Of the three probable scenarios for the bathroom door position during occupancy, open, closed or partly open, only partly open would provide the potential for air to return to the mechanical closet louvered door.

Figure 4.7: Unit-Type C1 Mechanical Closet and Hall Bathroom Doors



All of the units tested had lower outdoor air flow rates than the mechanical design specified. In fact, only two units provided at least fifty-percent of the design air flows and those units only performed at that level when space conditioning was called for by the thermostat. None of the units with a seven-inch outdoor air duct provided greater than forty percent of the design ventilation air flow during the ventilation duty cycle when no space conditioning was called for, and the average air flow under that condition was less than twenty-eight percent of design. Additionally, none of the units with a five-inch outdoor air duct provided greater than twenty-five percent of the design ventilation air flow during the ventilation duty cycle when no space conditioning was called for, and the average air flow under that condition was less than fourteen percent of design.

The low air flow test results were compounded given that the outdoor air was only being brought in for half of the designed ventilation duty cycle. Fortunately, the thermostat does have an option for increasing the ventilation run-time that the occupant can control. Unfortunately, though the EarthCraft program requires resident training of home systems operations, there is no guarantee that the owner will educate the occupants on the ventilation feature of the thermostat or that the occupants will remember how to use the thermostat as the ventilation feature is not intuitively labeled on the system. In addition, the energy penalty associated with the longer fan run-time from the occupant increasing the ventilation duty cycle may be a deterrent.

Due to the oversized cooling capacities in units A1, A2 and C1, the occupants may be less comfortable as the air conditioner may rapidly cool the space and cut-off causing longer periods between run-times and less effective humidity removal. Short-cycling further decreases the potential for the higher ventilation air flows recorded when the system was calling for cooling and increases the potential for the ventilation duty cycle to cut-on and re-evaporate moisture collected on the indoor coil. Fortunately, the stand-alone dehumidifiers in each unit will provide some humidity control. However, at least one of the dehumidifiers had a crimped drain line preventing the system from running once the bucket filled. If the unit requires more than thirty pints of moisture removal between maintenance visits, the dehumidifier will shut off to avoid overflowing.

5 CONCLUSION AND RECCOMENDATIONS

5.1 Conclusion

As improved construction methods have reduced uncontrolled natural infiltration in homes, more attention should be given to mechanical outdoor air ventilation to prevent indoor air quality issues. The purpose of this research was to determine whether central fan integrated supply (CFIS) whole-house ventilation systems installed within a sample set of multifamily dwelling units provided the amount of outdoor air ventilation specified by ASHRAE Standard 62.2 as required by the green building program being tracked for building certification and as designed by the mechanical engineer for the project. And if the systems were not meeting the targeted ventilation rates, what proposed solutions may be employed in the field to increase the potential for future installations to meet design criteria.

Testing the outdoor air ventilation rates in nineteen multifamily housing units with CFIS ventilation systems operated by an air cycler with a duty cycle of seventeen percent demonstrated that the units were not installed as designed and did not pull in enough outdoor ventilation air to meet ASHRAE Standard 62.2.

While technically accurate on paper, the original mechanical design failed to incorporate normal field installation realities of wood-framed construction by expecting metal ducts to run diagonally in a straight line through open web floor joists, and failing to provide enough detail to account for framing member locations causing additional duct obstructions. The design also expected the HVAC system to pull ninety CFM of air in through a five inch metal duct and one-hundred and thirty-five CFM of air in through a seven inch metal duct when the ducts were connected to an open return plenum in a centrally located mechanical closet. The open return plenum was not able to create enough static pressure on the outside air duct to draw in the design CFM despite the MERV 8 filters and higher fan speeds.

Lack of communication between the mechanical engineer, HVAC contractor and general contractor led to improperly installed equipment including incorrect fan motor wiring, inaccurate thermostat programming and additional elbows, crimps and blockages along the outside air ducts; none of which were caught during field installation sign-off inspections by the various contractors.

5.2 Recommendations

Further research should be conducted on CFIS ventilation systems with air cycler controllers ducted to return plenums and designed to meet ASHRAE 62.2 ventilation rates. A larger sample of multifamily and single family housing units should be tested to evaluate the effectiveness of this ventilation strategy when employed by typical contractors to better understand common field realities for system installation. Reduced return areas and in-line booster fans should be considered for increasing air flows in long duct runs with inadequate static pressures. Consideration should also be given to whether this strategy can realistically provide ASHRAE 62.2 ventilation rates without creating significant design and installation challenges, or causing unnecessarily high energy consumption rates for providing whole-house ventilation. Long-term monitoring should be performed to evaluate the impact of this ventilation strategy on energy consumption, indoor air quality and occupant health.

Municipalities should require whole-house ventilation strategies in all homes, and provide resources to builders and contractors to increase the awareness of the value of outdoor air ventilation in homes. The resources should include information on the need for whole-house ventilation, the impact outdoor air ventilation has on indoor air quality and occupant health, reference minimum ventilation performance standards and contain requirements for ensuring ventilation systems are working.

Mechanical engineers should be required to observe active construction sites to further understand the realities of typical HVAC installations so that they may adjust their designs and plans to best prepare contractors for success. Additionally, mechanical engineers and HVAC contractors should be required to commission all installations until the industry is able to provide more reliable service at a consistent rate.

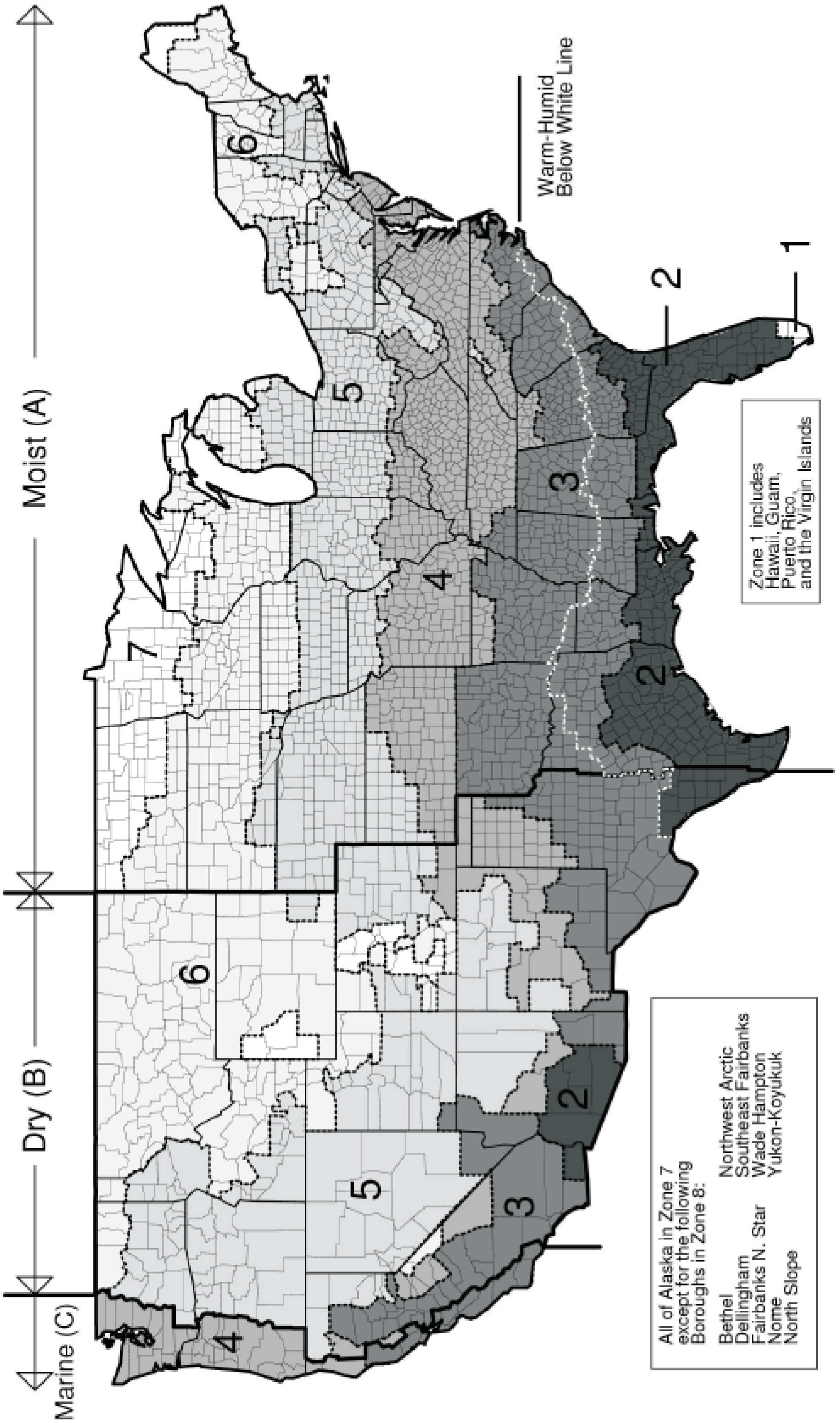
The Domestic Ventilation Compliance Guide created by Her Majesty's Government in England (2010) provides an excellent example of design and commissioning specifications for whole-house ventilation including detailed drawings on correct and incorrect installations and specific worksheets for commissioning data collection, and should be used as an example for mechanical engineers and building code development committees on how to best articulate ventilation requirements to contractors.

Builders should be required to provide residents information on the benefits of outdoor air ventilation, clear operation instructions for controlling whole-house ventilation flow rates, and guidance for maintaining ventilation equipment overtime. Health professionals should help reinforce the importance of whole-house ventilation by including questions about home ventilation rates and occupant use of ventilation systems when treating patients with respiratory ailments.

With further research and a holistic approach to addressing the need for improved ventilation in residences, the industry should be able to offer affordable, effective and reliable whole-house ventilation systems in new and existing homes across the U.S.

APPENDIX A

2009 IECC CLIMATE ZONE MAP


Marine (C)
Dry (B)
Moist (A)
Warm-Humid
Below White Line
7
6
5
4
3
2
1
6
5
4
3
2
Zone 1 includes
Hawaii, Guam,
Puerto Rico,
and the Virgin Islands
All of Alaska in Zone 7
except for the following
Boroughs in Zone 8:
Bethel
Dellingham
Fairbanks N. Star
Nome
North Slope
Northwest Arctic
Southeast Fairbanks
Wade Hampton
Yukon-Koyukuk

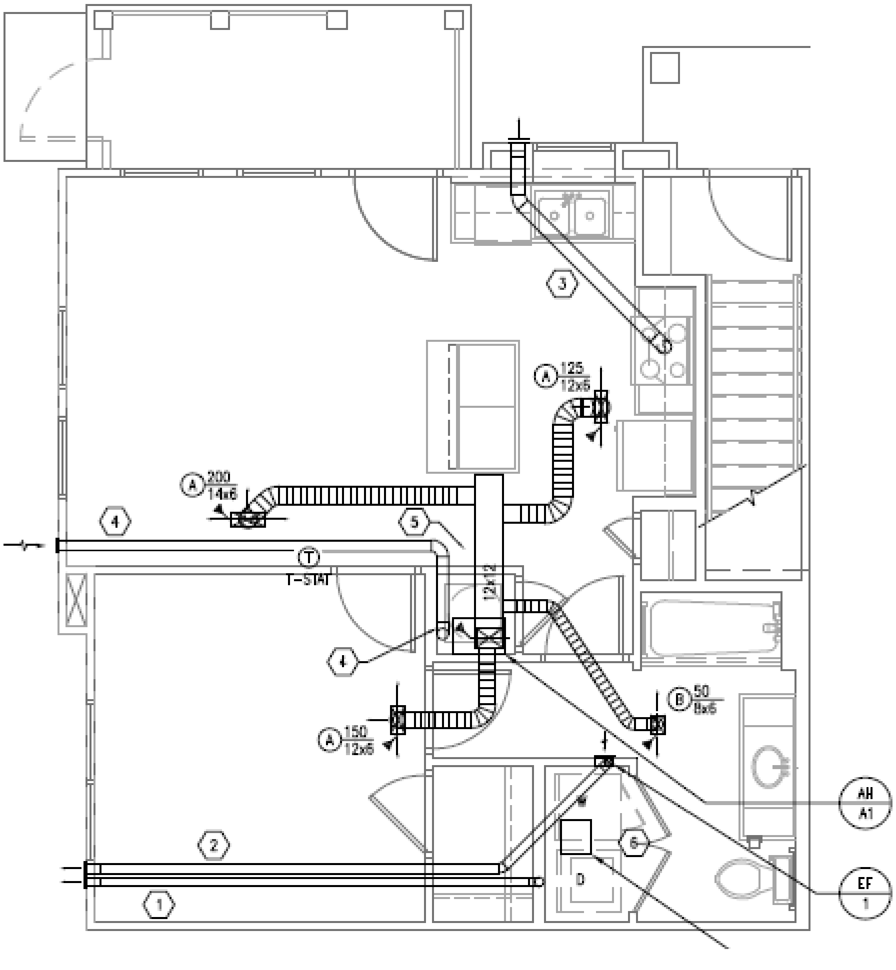
(ICC, 2009, p. 10)

U. S. CLIMATE ZONE MAP

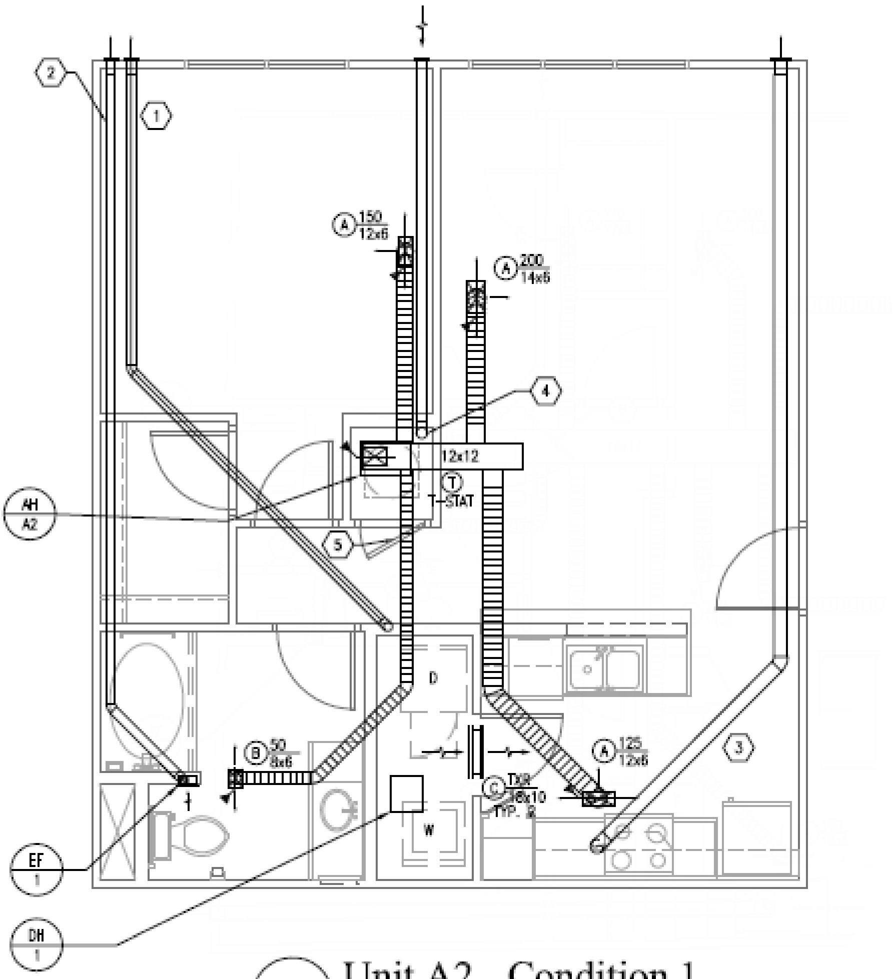
(EEBA, 2011)

APPENDIX B

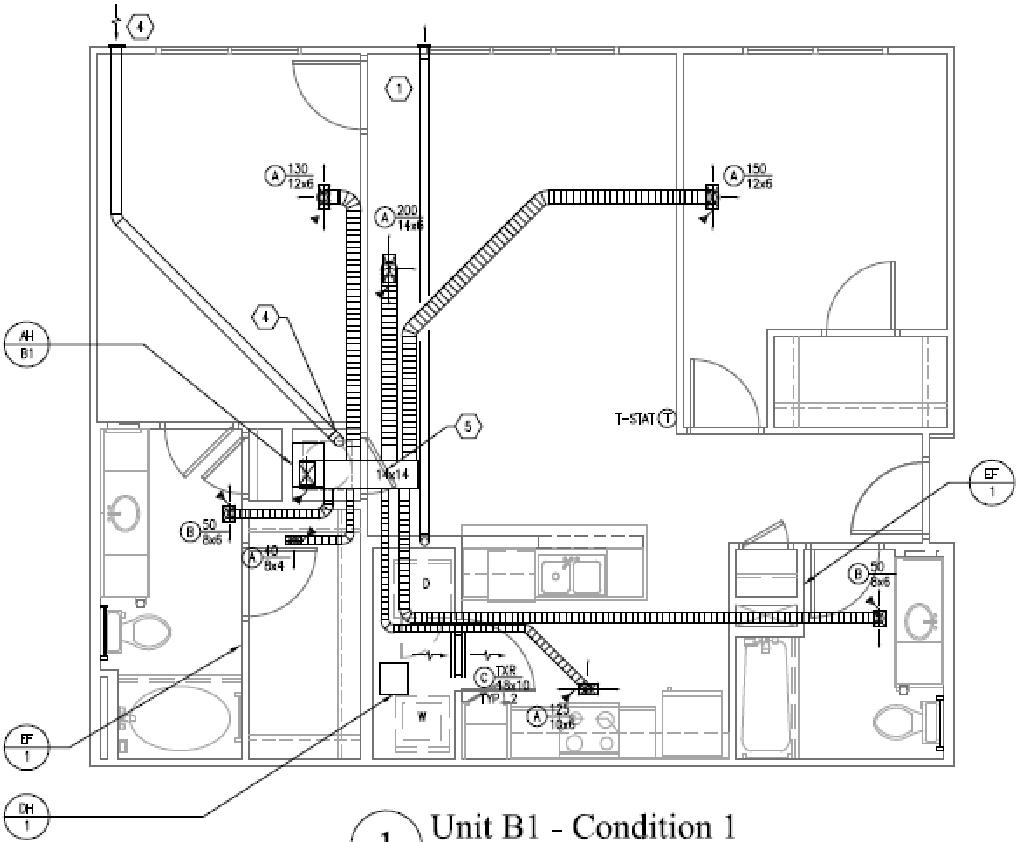
FLOOR AND MECHANICAL PLANS BY UNIT-TYPE TESTED



1 Unit A1 - Condition 1
Scale: 1/4"=1'-0" TYPICAL

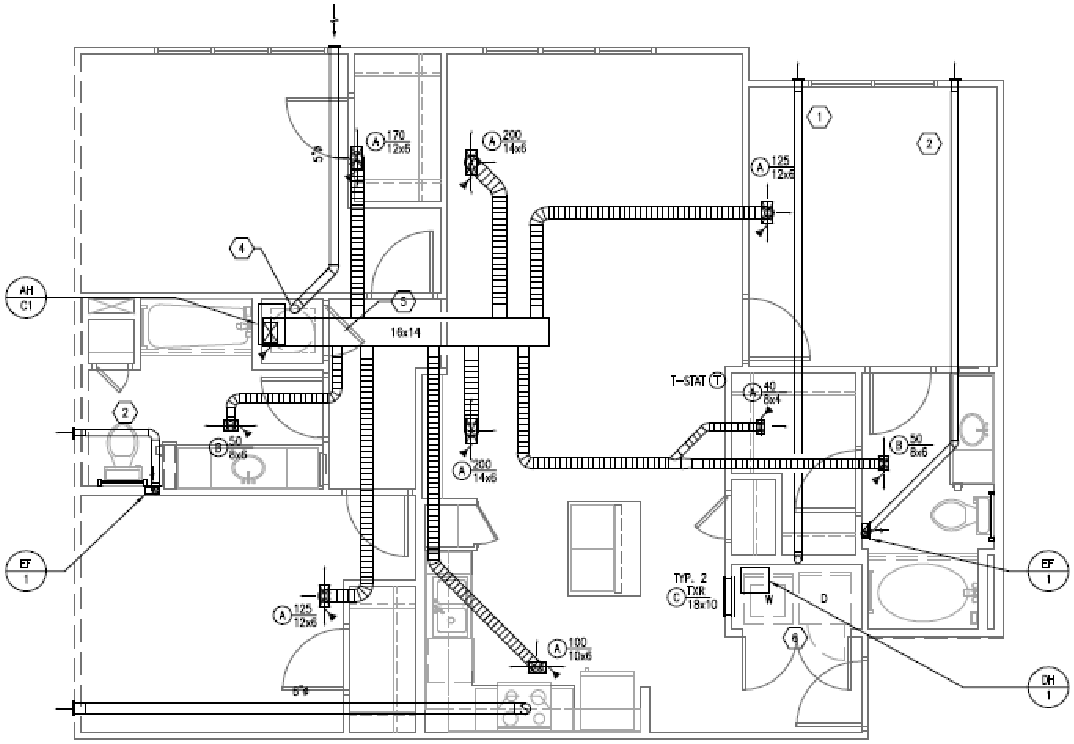


3 Unit A2 - Condition 1
Scale: 1/4"=1'-0"



1 Unit B1 - Condition 1

Scale: 1/4"=1'-0" TYPICAL



① Unit C1 - Condition 1
Scale: 1/4"=1'-0"

APPENDIX C

VENTILATION FLOW TEST RESULTS

LogDat2 Data File				
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	2	Unit #	3110	
Test Abbreviation:	Test 002			
Start Date:	10/8/2011	Notes:	Door Shut	Unit B1 H/C Cond. 2 Balcony Cond. 1
Start Time:	8:40:23	AC	9:05 AM	ESE 0.0
Duration (dd:hh:mm:ss):	0:00:00:56	58.5	70%	30.39 inHg
Number of points:	6			
Notes:	Test 002			
Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	217	57.89	74.1
	Minimum:	178	47.67	73.4
	Time of Minimum:	8:40:45	8:40:45	8:41:19
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	247	66.02	75
	Time of Maximum:	8:41:19	8:41:19	8:40:23
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T

MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	8:40:23	213	56.8	75
10/8/2011	8:40:33	190	50.87	74.8
10/8/2011	8:40:45	178	47.67	74.3
10/8/2011	8:40:56	227	60.6	73.9
10/8/2011	8:41:08	245	65.38	73.5
10/8/2011	8:41:19	247	66.02	73.4
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	3	Unit #	3110	
Test Abbreviation:	Test 003			
Start Date:	10/8/2011	Notes:	Door Shut	Unit B1 H/C Cond. 2 Balcony Cond. 1
Start Time:	8:42:29	Fan	9:05 AM	ESE 0.0
Duration (dd:hh:mm:ss):	0:00:00:52	58.5	70%	30.39 inHg
Number of points:	6			
Notes:	Test 003			
Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	153	40.78	73
	Minimum:	129	34.58	72.4
	Time of Minimum:	8:42:50	8:42:50	8:43:21
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	168	44.9	73.7
	Time of Maximum:	8:43:21	8:43:21	8:42:29
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	8:42:29	165	43.97	73.7
10/8/2011	8:42:39	149	39.82	73.5

10/8/2011	8:42:50	129	34.58	73.2
10/8/2011	8:43:00	148	39.51	72.7
10/8/2011	8:43:11	157	41.9	72.4
10/8/2011	8:43:21	168	44.9	72.4
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	4	Unit #	3111	
Test Abbreviation:	Test 004			
Start Date:	10/8/2011	Notes:	Unit B1 Cond. 5	
Start Time:	8:53:37	Fan	9:25 AM	SSE 0.0
Duration (dd:hh:mm:ss):	0:00:00:58	59.5	70%	30.41 inHg
Number of points:	6			
Notes:	Test 004			
Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	117	31.32	73.3
	Minimum:	100	26.65	72.9
	Time of Minimum:	8:54:11	8:54:11	8:54:23
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	143	38.15	73.9
	Time of Maximum:	8:53:48	8:53:48	8:53:37
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	8:53:37	109	29.07	73.9
10/8/2011	8:53:48	143	38.15	73.6
10/8/2011	8:53:59	101	27.04	73.3
10/8/2011	8:54:11	100	26.65	73
10/8/2011	8:54:23	128	34.23	72.9
10/8/2011	8:54:35	123	32.75	72.9
Model Number:	9535			

Serial Number:	T95350925008			
Test ID:	5	Unit #	3111	
Test Abbreviation:	Test 005			
Start Date:	10/8/2011	Notes:	Unit B1 Cond. 5	
Start Time:	8:55:38	AC	9:25 AM	SSE 0.0
Duration (dd:hh:mm:ss):	0:00:01:02	59.5	70%	30.41 inHg
Number of points:	6			
Notes:	Test 005			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	210	56.02	72.5
	Minimum:	173	46.27	71.8
	Time of Minimum:	8:56:40	8:56:40	8:56:26
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	250	66.83	73.5
	Time of Maximum:	8:56:13	8:56:13	8:55:38
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T
	Cal. Date	6/18/2009	6/18/2009

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	8:55:38	197	52.6	73.5
10/8/2011	8:55:49	209	55.8	73.1
10/8/2011	8:56:01	226	60.49	72.5
10/8/2011	8:56:13	250	66.83	72.1
10/8/2011	8:56:26	203	54.14	71.8
10/8/2011	8:56:40	173	46.27	72
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	8	Unit #	3108	
Test Abbreviation:	Test 008			
Start Date:	10/8/2011	Notes:	Unit A2 Cond.	

			7	
Start Time:	9:36:14	Fan	9:40AM	N 0.0
Duration (dd:hh:mm:ss):	0:00:00:33	60.6	70%	30.41 inHg
Number of points:	4			
Notes:	Test 008			
Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	96	13.11	72.8
	Minimum:	68	9.34	72.5
	Time of Minimum:	9:36:37	9:36:37	9:36:47
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	126	17.13	73.1
	Time of Maximum:	9:36:14	9:36:14	9:36:14
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	9:36:14	126	17.13	73.1
10/8/2011	9:36:25	120	16.43	72.9
10/8/2011	9:36:37	68	9.34	72.7
10/8/2011	9:36:47	70	9.53	72.5
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	9	Unit #	3108	
Test Abbreviation:	Test 009			
Start Date:	10/8/2011	Notes:	Unit A2 Cond. 7	
Start Time:	9:37:39	AC	9:40AM	N 0.0
Duration (dd:hh:mm:ss):	0:00:00:37	60.6	70%	30.41 inHg
Number of points:	4			
Notes:	Test 009			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	179	24.37	71.7
	Minimum:	121	16.53	71.4
	Time of Minimum:	9:38:16	9:38:16	9:38:16
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	248	33.84	72.1
	Time of Maximum:	9:37:52	9:37:52	9:37:39
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T
	Cal. Date	6/18/2009	6/18/2009

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	9:37:39	207	28.16	72.1
10/8/2011	9:37:52	248	33.84	71.8
10/8/2011	9:38:06	139	18.94	71.6
10/8/2011	9:38:16	121	16.53	71.4
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	10	Unit #	3106	
Test Abbreviation:	Test 010			
Start Date:	10/8/2011	Notes:	Unit A2 Cond. 2 Balcony Cond 1	
Start Time:	9:47:07	Fan	10:16AM	NE 0.0
Duration (dd:hh:mm:ss):	0:00:00:33	66.4	64%	30.41 inHg
Number of points:	4			
Notes:	Test 010			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	160	21.8	73.1
	Minimum:	136	18.54	72.9
	Time of Minimum:	9:47:07	9:47:07	9:47:07

	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	184	25.07	73.2
	Time of Maximum:	9:47:30	9:47:30	9:47:40
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	9:47:07	136	18.54	72.9
10/8/2011	9:47:18	183	24.96	73.1
10/8/2011	9:47:30	184	25.07	73.2
10/8/2011	9:47:40	137	18.62	73.2
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	11	Unit #	3106	
Test Abbreviation:	Test 011			
Start Date:	10/8/2011	Notes:	Unit A2 Cond. 2 Balcony Cond 1	
Start Time:	9:48:37	AC	10:16AM	NE 0.0
Duration (dd:hh:mm:ss):	0:00:00:34	66.4	64%	30.41 inHg
Number of points:	4			
Notes:	Test 011			
Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	256	34.93	73.5
	Minimum:	223	30.39	73.3
	Time of Minimum:	9:49:11	9:49:11	9:49:11
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	295	40.2	73.6
	Time of Maximum:	9:48:37	9:48:37	9:48:37
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	9:48:37	295	40.2	73.6
10/8/2011	9:48:48	265	36.16	73.5
10/8/2011	9:49:00	242	32.97	73.4
10/8/2011	9:49:11	223	30.39	73.3
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	13	Unit #	3107	
Test Abbreviation:	Test 013			
Start Date:	10/8/2011	Notes:	Unit B1 Cond. 5	
Start Time:	9:57:33	Fan	10:20AM	ENE 0.0
Duration (dd:hh:mm:ss):	0:00:00:54	66.9	63%	30.41 inHg
Number of points:	6			
Notes:	Test 013			
Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	120	32.11	71.7
	Minimum:	71	19.02	71.7
	Time of Minimum:	9:57:55	9:57:55	9:57:33
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	169	45.17	71.8
	Time of Maximum:	9:58:07	9:58:07	9:58:07
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	9:57:33	130	34.85	71.7

10/8/2011	9:57:44	154	41.06	71.7
10/8/2011	9:57:55	71	19.02	71.7
10/8/2011	9:58:07	169	45.17	71.8
10/8/2011	9:58:17	88	23.44	71.8
10/8/2011	9:58:27	109	29.09	71.8
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	14	Unit #	3107	
Test Abbreviation:	Test 014			
Start Date:	10/8/2011	Notes:	Unit B1 Cond. 5	
Start Time:	9:59:29	AC	10:20AM	ENE 0.0
Duration (dd:hh:mm:ss):	0:00:00:54	66.9	63%	30.41 inHg
Number of points:	6			
Notes:	Test 014			
Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	205	54.92	71.3
	Minimum:	158	42.35	71
	Time of Minimum:	9:59:29	9:59:29	10:00:23
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	267	71.37	71.7
	Time of Maximum:	10:00:03	10:00:03	9:59:29
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	9:59:29	158	42.35	71.7
10/8/2011	9:59:42	171	45.65	71.5
10/8/2011	9:59:52	210	56.1	71.3
10/8/2011	10:00:03	267	71.37	71.2
10/8/2011	10:00:13	222	59.4	71.1
10/8/2011	10:00:23	204	54.65	71

Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	15	Unit #	3102	
Test Abbreviation:	Test 015			
Start Date:	10/8/2011	Notes:	Unit B1 H/C Cond. 2 Balcony Cond 1	
Start Time:	10:07:53	Fan	10:35AM	E 0.0
Duration (dd:hh:mm:ss):	0:00:00:54	67.8	62%	30.41 inHg
Number of points:	6			
Notes:	Test 015			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	173	46.24	71.9
	Minimum:	117	31.3	71.9
	Time of Minimum:	10:08:47	10:08:47	10:07:53
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	258	69.06	72
	Time of Maximum:	10:08:26	10:08:26	10:08:47
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T
	Cal. Date	6/18/2009	6/18/2009

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	10:07:53	186	49.76	71.9
10/8/2011	10:08:03	141	37.69	71.9
10/8/2011	10:08:14	196	52.25	71.9
10/8/2011	10:08:26	258	69.06	71.9
10/8/2011	10:08:37	140	37.36	71.9
10/8/2011	10:08:47	117	31.3	72

Model Number:	9535		
Serial Number:	T95350925008		
Test ID:	16	Unit #	3102
Test Abbreviation:	Test 016		

Start Date:	10/8/2011	Notes:	Unit B1 H/C Cond. 2 Balcony Cond 1	
Start Time:	10:09:51	AC	10:35AM	E 0.0
Duration (dd:hh:mm:ss):	0:00:00:55	67.8	62%	30.41 inHg
Number of points:	6			
Notes:	Test 016			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	216	57.7	72.1
	Minimum:	185	49.41	71.9
	Time of Minimum:	10:09:51	10:09:51	10:10:36
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	258	68.98	72.3
	Time of Maximum:	10:10:26	10:10:26	10:09:51
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T
	Cal. Date	6/18/2009	6/18/2009

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	10:09:51	185	49.41	72.3
10/8/2011	10:10:01	213	57.05	72.2
10/8/2011	10:10:14	187	50.02	72.1
10/8/2011	10:10:26	258	68.98	72
10/8/2011	10:10:36	242	64.56	71.9
10/8/2011	10:10:46	210	56.19	71.9
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	17 A	Unit #	3103	
Test Abbreviation:	Test 017			
Start Date:	10/8/2011	Notes:	corrected	Unit C1 H/C Cond. 1 Side Cond 2
Start Time:	10:19:27	Fan	10:45AM	E 1.3

Duration (dd:hh:mm:ss):	void	69.3	60%	30.41 inHg
Number of points:	6			
Notes:	Test 017			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	136	36.4	73.4
	Minimum:	42	11.31	72.9
	Time of Minimum:	10:20:45	10:20:45	10/8/2011
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	206	54.92	73.8
	Time of Maximum:	10:19:43	10:19:43	10:21:08
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T
	Cal. Date	6/18/2009	6/18/2009

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	10:19:27	203	54.29	72.9
10/8/2011	10:19:43	206	54.92	73.1
10/8/2011	10:19:57	161	43.09	73.3
10/8/2011	10:20:45	42	11.31	73.7
10/8/2011	10:21:08	130	34.82	73.8
10/8/2011	10:21:20	74	19.7	73.8
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	17 B	Unit #	3103	
Test Abbreviation:	Test 017			
Start Date:	10/8/2011	Notes:	corrected	Unit C1 H/C Cond. 1 Side Cond 2
Start Time:	10:19:27	AC	10:45AM	E 1.3
Duration (dd:hh:mm:ss):	void	69.3	60%	30.41 inHg

Number of points:	6
Notes:	Test 017

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	160	42.7	73.1
	Minimum:	58	15.37	72.8
	Time of Minimum:	10:23:10	10:23:10	10:23:10
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	266	71.09	73.8
	Time of Maximum:	10:22:27	10:22:27	10:22:27
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T
	Cal. Date	6/18/2009	6/18/2009

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	10:22:27	266	71.09	73.8
10/8/2011	10:22:44	216	57.64	73.4
10/8/2011	10:22:56	116	30.9	73.1
10/8/2011	10:23:10	58	15.37	72.8
10/8/2011	10:23:21	115	30.73	72.8
10/8/2011	10:23:31	189	50.52	72.8
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	19	Unit #	3205	
Test Abbreviation:	Test 019			
Start Date:	10/8/2011	Notes:	Unit B1 Cond. 6 Balcony Cond 3	
Start Time:	10:38:09	Fan	11:05AM	NNE 0.0
Duration (dd:hh:mm:ss):	0:00:00:55	68.2	60%	30.41 inHg
Number of points:	6			
Notes:	Test 019			

Statistics	Channel:	Velocity	Flow	T

	Units:	ft/min	cf/m	°F
	Average:	136	36.41	73.6
	Minimum:	108	28.83	73.5
	Time of Minimum:	10:38:55	10:38:55	10:38:55
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	192	51.22	73.9
	Time of Maximum:	10:38:09	10:38:09	10:38:09
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	10:38:09	192	51.22	73.9
10/8/2011	10:38:20	122	32.64	73.8
10/8/2011	10:38:32	161	43.11	73.6
10/8/2011	10:38:44	117	31.14	73.5
10/8/2011	10:38:55	108	28.83	73.5
10/8/2011	10:39:04	118	31.51	73.5
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	20	Unit #	3205	
Test Abbreviation:	Test 020			
Start Date:	10/8/2011	Notes:	Unit B1 Cond. 6 Balcony Cond 3	
Start Time:	10:40:08	AC	11:05AM	NNE 0.0
Duration (dd:hh:mm:ss):	0:00:00:58	68.2	60%	30.41 inHg
Number of points:	6			
Notes:	Test 020			
Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	298	79.59	72.9
	Minimum:	265	70.93	72.6
	Time of Minimum:	10:40:55	10:40:55	10:40:55

	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	378	101.14	73.5
	Time of Maximum:	10:40:08	10:40:08	10:40:08
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	10:40:08	378	101.14	73.5
10/8/2011	10:40:19	319	85.35	73.3
10/8/2011	10:40:33	274	73.33	72.9
10/8/2011	10:40:44	271	72.34	72.7
10/8/2011	10:40:55	265	70.93	72.6
10/8/2011	10:41:06	279	74.45	72.6
Model Number:	9535			
Serial Number:	T95350925008			
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	23	Unit #	3210	
Test Abbreviation:	Test 023			
Start Date:	10/8/2011	Notes:	Unit B1 Cond. 2 Balcony Cond 2	
Start Time:	11:03:10	Fan	11:27AM	NNW 0.9
Duration (dd:hh:mm:ss):	0:00:01:06	68.2	60%	30.40 inHg
Number of points:	6			
Notes:	Test 023			
Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	196	52.29	74.1
	Minimum:	159	42.5	73.9
	Time of Minimum:	11:03:53	11:03:53	11:04:04
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	226	60.33	74.4

	Time of Maximum:	11:04:04	11:04:04	11:03:10
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	11:03:10	220	58.81	74.4
10/8/2011	11:03:25	221	59.19	74.3
10/8/2011	11:03:43	172	45.93	74.1
10/8/2011	11:03:53	159	42.5	73.9
10/8/2011	11:04:04	226	60.33	73.9
10/8/2011	11:04:16	176	46.97	73.9
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	24	Unit #	3210	
Test Abbreviation:	Test 024			
Start Date:	10/8/2011	Notes:	Unit B1 Cond. 2 Balcony Cond 2	
Start Time:	11:05:14	AC	11:27AM	NNW 0.9
Duration (dd:hh:mm:ss):	0:00:00:56	68.2	60%	30.40 inHg
Number of points:	6			
Notes:	Test 024			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	258	68.98	74.1
	Minimum:	220	58.68	73.9
	Time of Minimum:	11:05:33	11:05:33	11:05:58
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	294	78.61	74.3
	Time of Maximum:	11:05:14	11:05:14	11:05:14
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	11:05:14	294	78.61	74.3
10/8/2011	11:05:24	282	75.25	74.2
10/8/2011	11:05:33	220	58.68	74.1
10/8/2011	11:05:44	235	62.68	73.9
10/8/2011	11:05:58	270	72.22	73.9
10/8/2011	11:06:10	249	66.46	74
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	25	Unit #	3209	
Test Abbreviation:	Test 025			
Start Date:	10/8/2011	Notes:	Unit B1 Cond. 6 Balcony Cond 3	
Start Time:	11:15:51	Fan	11:44AM	N 0.9
Duration (dd:hh:mm:ss):	0:00:00:51	68.5	60%	30.41 inHg
Number of points:	6			
Notes:	Test 025			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	202	54.01	74.9
	Minimum:	169	45.04	74.7
	Time of Minimum:	11:15:51	11:15:51	11:16:32
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	230	61.54	75
	Time of Maximum:	11:16:32	11:16:32	11:15:51
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F

10/8/2011	11:15:51	169	45.04	75
10/8/2011	11:16:01	221	59.1	75
10/8/2011	11:16:11	195	52.18	74.9
10/8/2011	11:16:21	221	58.96	74.8
10/8/2011	11:16:32	230	61.54	74.7
10/8/2011	11:16:42	177	47.25	74.8
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	26	Unit #	3209	
Test Abbreviation:	Test 026			
Start Date:	10/8/2011	Notes:	Unit B1 Cond. 6 Balcony Cond 3	
Start Time:	11:17:50	AC	11:44AM	N 0.9
Duration (dd:hh:mm:ss):	0:00:01:05	68.5	60%	30.41 inHg
Number of points:	6			
Notes:	Test 026			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	225	60.07	74.6
	Minimum:	187	49.88	74.3
	Time of Minimum:	11:18:34	11:18:34	11:18:45
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	288	77	75.1
	Time of Maximum:	11:18:22	11:18:22	11:17:50
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T
	Cal. Date	6/18/2009	6/18/2009

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	11:17:50	204	54.39	75.1
10/8/2011	11:18:09	234	62.59	74.8
10/8/2011	11:18:22	288	77	74.5
10/8/2011	11:18:34	187	49.88	74.3
10/8/2011	11:18:45	212	56.7	74.3

10/8/2011	11:18:55	224	59.86	74.3
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	27	Unit #	3208	
Test Abbreviation:	Test 027			
Start Date:	10/8/2011	Notes:	window closed	Unit A2 Cond. 7
Start Time:	11:30:44	Fan	11:50AM	NNW 0.0
Duration (dd:hh:mm:ss):	0:00:00:33	68.5	60%	30.41 inHg
Number of points:	4			
Notes:	Test 027			
Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	70	9.52	70.1
	Minimum:	24	3.25	70
	Time of Minimum:	11:30:44	11:30:44	11:30:44
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	103	14.01	70.3
	Time of Maximum:	11:31:07	11:31:07	11:31:17
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	11:30:44	24	3.25	70
10/8/2011	11:30:55	71	9.7	70.1
10/8/2011	11:31:07	103	14.01	70.2
10/8/2011	11:31:17	82	11.12	70.3
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	28	Unit #	3208	
Test Abbreviation:	Test 028			
Start Date:	10/8/2011	Notes:	window closed	Unit A2

				Cond. 7
Start Time:	11:32:47	AC	11:50AM	NNW 0.0
Duration (dd:hh:mm:ss):	0:00:00:31	68.5	60%	30.41 inHg
Number of points:	4			
Notes:	Test 028			
Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	105	14.31	70.4
	Minimum:	80	10.9	70.3
	Time of Minimum:	11:33:07	11:33:07	11:33:18
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	141	19.19	70.5
	Time of Maximum:	11:32:56	11:32:56	11:32:47
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	11:32:47	111	15.17	70.5
10/8/2011	11:32:56	141	19.19	70.5
10/8/2011	11:33:07	80	10.9	70.4
10/8/2011	11:33:18	88	12	70.3
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	29	Unit #	3201	
Test Abbreviation:	Test 029			
Start Date:	10/8/2011	Notes:	corrected	Unit C1 Cond.2 Side Cond 2 Balcony Cond 2
Start Time:	11:40:33	Fan	12:09PM	NNW 0.0
Duration (dd:hh:mm:ss):	void	69.1	60%	30.40 inHg

Number of points:	6			
Notes:	Test 029			
Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	110.17	29.43	71.87
	Minimum:	70	18.7	71.3
	Time of Minimum:	11:40:57	11:40:57	11:40:33
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	175	46.84	72.4
	Time of Maximum:	11:40:33	11:40:33	11:41:33
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	11:40:33	175	46.84	71.3
10/8/2011	11:40:45	114	30.46	71.6
10/8/2011	11:40:57	70	18.7	71.7
10/8/2011	11:41:09	137	36.5	72
10/8/2011	11:41:24	88	23.57	72.2
10/8/2011	11:41:33	77	20.5	72.4
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	30	Unit #	3201	
Test Abbreviation:	Test 030			
Start Date:	10/8/2011	Notes:	Unit C1 Cond.2 Side Cond 2 Balcony Cond 2	
Start Time:	11:44:43	AC	12:09PM	NNW 0.0
Duration (dd:hh:mm:ss):	0:00:01:02	69.1	60%	30.40 inHg
Number of points:	6			
Notes:	Test 030			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	232	61.99	72.5
	Minimum:	187	49.92	72.3
	Time of Minimum:	11:45:33	11:45:33	11:45:45
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	305	81.5	72.7
	Time of Maximum:	11:45:45	11:45:45	11:44:43
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T
	Cal. Date	6/18/2009	6/18/2009

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	11:44:43	200	53.58	72.7
10/8/2011	11:44:58	194	51.94	72.7
10/8/2011	11:45:12	262	70.1	72.6
10/8/2011	11:45:23	243	64.92	72.5
10/8/2011	11:45:33	187	49.92	72.4
10/8/2011	11:45:45	305	81.5	72.3

Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	31	Unit #	3303	
Test Abbreviation:	Test 031			
Start Date:	10/8/2011	Notes:	Unit C1 Cond. 6 Side Cond 2	
Start Time:	12:05:42	Fan	12:35PM	SSW 0.0
Duration (dd:hh:mm:ss):	0:00:01:13	70.3	58%	30.39 inHg
Number of points:	6			
Notes:	Test 031			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	92	24.47	76
	Minimum:	63	16.8	75.6
	Time of Minimum:	12:06:21	12:06:21	12:05:42

	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	126	33.8	76.3
	Time of Maximum:	12:06:45	12:06:45	12:06:55
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T
	Cal. Date	6/18/2009	6/18/2009

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	12:05:42	67	17.91	75.6
10/8/2011	12:06:11	102	27.35	75.8
10/8/2011	12:06:21	63	16.8	76
10/8/2011	12:06:34	112	30.02	76
10/8/2011	12:06:45	126	33.8	76.1
10/8/2011	12:06:55	78	20.96	76.3
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	32	Unit #	3303	
Test Abbreviation:	Test 032			
Start Date:	10/8/2011	Notes:	Unit C1 Cond. 6 Side Cond 2	
Start Time:	12:07:47	AC	12:35PM	SSW 0.0
Duration (dd:hh:mm:ss):	0:00:00:54	70.3	58%	30.39 inHg
Number of points:	6			
Notes:	Test 032			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	230	61.44	77
	Minimum:	209	55.81	76.4
	Time of Minimum:	12:08:09	12:08:09	12:08:41
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	251	67.14	77.8
	Time of Maximum:	12:07:47	12:07:47	12:07:47
	Date of	10/8/2011	10/8/2011	10/8/2011

	Maximum:			

Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	12:07:47	251	67.14	77.8
10/8/2011	12:07:57	240	64.22	77.6
10/8/2011	12:08:09	209	55.81	77.2
10/8/2011	12:08:20	211	56.33	76.8
10/8/2011	12:08:31	231	61.66	76.5
10/8/2011	12:08:41	237	63.45	76.4
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	33	Unit #	3302	
Test Abbreviation:	Test 033			
Start Date:	10/8/2011	Notes:	Unit B1 Cond. 2 Balcony Cond 2	
Start Time:	12:14:29	Fan	12:40PM	SSE 0.0
Duration (dd:hh:mm:ss):	0:00:00:50	70.7	58%	30.39 inHg
Number of points:	6			
Notes:	Test 033			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	150	40.07	73.7
	Minimum:	133	35.5	73.7
	Time of Minimum:	12:15:00	12:15:00	12:14:29
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	182	48.61	73.7
	Time of Maximum:	12:14:29	12:14:29	12:14:39
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	12:14:29	182	48.61	73.7
10/8/2011	12:14:39	150	40.04	73.7
10/8/2011	12:14:50	135	36.07	73.7
10/8/2011	12:15:00	133	35.5	73.7
10/8/2011	12:15:09	136	36.47	73.7
10/8/2011	12:15:19	164	43.74	73.7

Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	34	Unit #	3302	
Test Abbreviation:	Test 034			
Start Date:	10/8/2011	Notes:	Unit B1 Cond. 2 Balcony Cond 2	
Start Time:	12:16:17	AC	12:40PM	SSE 0.0
Duration (dd:hh:mm:ss):	0:00:00:52	70.7	58%	30.39 inHg
Number of points:	6			
Notes:	Test 034			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	240	64.05	73.6
	Minimum:	220	58.68	73.3
	Time of Minimum:	12:16:17	12:16:17	12:17:09
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	269	72	73.9
	Time of Maximum:	12:16:49	12:16:49	12:16:17
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T
	Cal. Date	6/18/2009	6/18/2009

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	12:16:17	220	58.68	73.9
10/8/2011	12:16:27	227	60.74	73.8
10/8/2011	12:16:38	257	68.81	73.7

10/8/2011	12:16:49	269	72	73.6
10/8/2011	12:16:59	238	63.73	73.4
10/8/2011	12:17:09	226	60.32	73.3
Model Number:	9535			
Serial Number:	T95350925008			
Serial Number:	T95350925008			
Test ID:	37	Unit #	3312	
Test Abbreviation:	Test 037			
Start Date:	10/8/2011	Notes:	Unit B1 Cond. 5	
Start Time:	14:04:51	Fan	2:34PM	ESE 0.0
Duration (dd:hh:mm:ss):	0:00:00:55	75	53%	30.35 inHg
Number of points:	6			
Notes:	Test 037			
Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	45	12.09	75.5
	Minimum:	11	2.9	75
	Time of Minimum:	14:05:02	14:05:02	14:04:51
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	69	18.57	76
	Time of Maximum:	14:05:35	14:05:35	14:05:46
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	14:04:51	51	13.59	75
10/8/2011	14:05:02	11	2.9	75.2
10/8/2011	14:05:12	40	10.56	75.4
10/8/2011	14:05:24	46	12.4	75.6
10/8/2011	14:05:35	69	18.57	75.8
10/8/2011	14:05:46	54	14.51	76
Model Number:	9535			

Serial Number:	T95350925008			
Test ID:	38	Unit #	3312	
Test Abbreviation:	Test 038			
Start Date:	10/8/2011	Notes:	Unit B1 Cond. 5	
Start Time:	14:06:48	AC	2:34PM	ESE 0.0
Duration (dd:hh:mm:ss):	0:00:00:53	75	53%	30.35 inHg
Number of points:	6			
Notes:	Test 038			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	145	38.73	77.4
	Minimum:	126	33.8	76.9
	Time of Minimum:	14:07:31	14:07:31	14:06:48
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	161	43	77.7
	Time of Maximum:	14:07:09	14:07:09	14:07:31
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T
	Cal. Date	6/18/2009	6/18/2009

Date MM/dd/yyyy	Time hh:mm:ss	Velocity ft/min	Flow cf/m	T °F
10/8/2011	14:06:48	151	40.42	76.9
10/8/2011	14:06:59	150	40.06	77.2
10/8/2011	14:07:09	161	43	77.5
10/8/2011	14:07:19	136	36.25	77.6
10/8/2011	14:07:31	126	33.8	77.7
10/8/2011	14:07:41	145	38.83	77.7

Model Number:	9535		
Serial Number:	T95350925008		
Test ID:	39	Unit #	3305
Test Abbreviation:	Test 039		
Start Date:	10/8/2011	Notes:	Unit B1 Cond. 6 Balcony Cond.

			3	
Start Time:	14:15:28	Fan	2:45PM	NNW 0.0
Duration (dd:hh:mm:ss):	0:00:00:49	75	52%	30.34 inHg
Number of points:	6			
Notes:	Test 039			
Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	148	39.43	75.9
	Minimum:	101	26.87	75.8
	Time of Minimum:	14:15:47	14:15:47	14:15:28
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	169	45.12	76.1
	Time of Maximum:	14:16:07	14:16:07	14:16:17
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	14:15:28	144	38.39	75.8
10/8/2011	14:15:37	164	43.82	75.9
10/8/2011	14:15:47	101	26.87	75.9
10/8/2011	14:15:57	146	38.97	76
10/8/2011	14:16:07	169	45.12	76
10/8/2011	14:16:17	163	43.43	76.1
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	40	Unit #	3305	
Test Abbreviation:	Test 040			
Start Date:	10/8/2011	Notes:	Unit B1 Cond. 6 Balcony Cond. 3	
Start Time:	14:17:10	AC	2:45PM	NNW 0.0
Duration (dd:hh:mm:ss):	0:00:00:51	75	52%	30.34 inHg

Number of points: 6
Notes: Test 040

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	248	66.31	76.2
	Minimum:	234	62.61	76.1
	Time of Minimum:	14:17:41	14:17:41	14:17:41
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	264	70.49	76.3
	Time of Maximum:	14:17:10	14:17:10	14:17:10
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T
	Cal. Date	6/18/2009	6/18/2009

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	14:17:10	264	70.49	76.3
10/8/2011	14:17:21	253	67.5	76.3
10/8/2011	14:17:31	236	63.13	76.1
10/8/2011	14:17:41	234	62.61	76.1
10/8/2011	14:17:51	251	66.96	76.1
10/8/2011	14:18:01	251	67.19	76.1

Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	41	Unit #	3308	
Test Abbreviation:	Test 041			
Start Date:	10/8/2011	Notes:	Unit A2 Cond. 7	
Start Time:	14:22:57	Fan	2:50PM	WSW 0.0
Duration (dd:hh:mm:ss):	0:00:00:32	75.4	53%	30.34 inHg
Number of points:	4			
Notes:	Test 041			

Statistics	Channel:	Velocity	Flow	T

	Units:	ft/min	cf/m	°F
	Average:	81	11.02	73.9
	Minimum:	17	2.33	73.8
	Time of Minimum:	14:22:57	14:22:57	14:22:57
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	125	17.03	73.9
	Time of Maximum:	14:23:19	14:23:19	14:23:19
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T
	Cal. Date	6/18/2009	6/18/2009

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	14:22:57	17	2.33	73.8
10/8/2011	14:23:07	88	11.98	73.9
10/8/2011	14:23:19	125	17.03	73.9
10/8/2011	14:23:29	93	12.73	73.9
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	42	Unit #	3308	
Test Abbreviation:	Test 042			
Start Date:	10/8/2011	Notes:	Unit A2 Cond. 7	
Start Time:	14:24:37	AC	2:50PM	WSW 0.0
Duration (dd:hh:mm:ss):	0:00:00:32	75.4	53%	30.34 inHg
Number of points:	4			
Notes:	Test 042			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	162	22.14	75.3
	Minimum:	125	17.03	75
	Time of Minimum:	14:25:09	14:25:09	14:24:37
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011

	Maximum:	196	26.71	75.4
	Time of Maximum:	14:24:58	14:24:58	14:24:58
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	14:24:37	155	21.07	75
10/8/2011	14:24:47	174	23.76	75.2
10/8/2011	14:24:58	196	26.71	75.4
10/8/2011	14:25:09	125	17.03	75.4
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	43	Unit #	3113	
Test Abbreviation:	Test 043			
Start Date:	10/8/2011	Notes:	Unit A1 Cond. 2	
Start Time:	14:52:15	Fan	3:21PM	ESE 0.0
Duration (dd:hh:mm:ss):	0:00:00:38	74.8	51%	30.33 inHg
Number of points:	4			
Notes:	Test 043			
Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	93	12.72	75.8
	Minimum:	75	10.27	75.3
	Time of Minimum:	14:52:53	14:52:53	14:52:53
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	108	14.71	76.3
	Time of Maximum:	14:52:15	14:52:15	14:52:15
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	

	Cal. Date	6/18/2009	6/18/2009	

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	14:52:15	108	14.71	76.3
10/8/2011	14:52:29	104	14.21	76
10/8/2011	14:52:40	86	11.7	75.7
10/8/2011	14:52:53	75	10.27	75.3
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	44	Unit #	3113	
Test Abbreviation:	Test 044			
Start Date:	10/8/2011	Notes:	Unit A1 Cond. 2	
Start Time:	14:53:39	AC	3:21PM	ESE 0.0
Duration (dd:hh:mm:ss):	0:00:00:32	74.8	51%	30.33 inHg
Number of points:	4			
Notes:	Test 044			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	149	20.3	74.4
	Minimum:	121	16.55	74.1
	Time of Minimum:	14:54:11	14:54:11	14:54:11
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	175	23.84	74.6
	Time of Maximum:	14:53:39	14:53:39	14:53:39
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T
	Cal. Date	6/18/2009	6/18/2009

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	14:53:39	175	23.84	74.6
10/8/2011	14:53:50	167	22.76	74.5
10/8/2011	14:54:01	133	18.07	74.4

10/8/2011	14:54:11	121	16.55	74.1
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	47 A	Unit #	3114	
Test Abbreviation:	Test 047			
Start Date:	10/8/2011	Notes:	corrected	Unit A1 Cond. 2
Start Time:	15:07:29	Fan	3:30PM	ESE 0.9
Duration (dd:hh:mm:ss):	0:00:02:08	75	49%	30.32 inHg
Number of points:	4			
Notes:	Test 047			
Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	15	2.05	68.975
	Minimum:	0	0	68.9
	Time of Minimum:	15:07:29	15:07:29	15:08:04
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	44	6	69.1
	Time of Maximum:	15:08:04	15:08:04	15:07:29
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011
Calibration	Sensor:	Velocity	T	
	Cal. Date	6/18/2009	6/18/2009	
Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	15:07:29	0	0	69.1
10/8/2011	15:07:45	12	1.67	69
10/8/2011	15:07:54	4	0.53	68.9
10/8/2011	15:08:04	44	6	68.9
Model Number:	9535			
Serial Number:	T95350925008			
Test ID:	47 B	Unit #	3114	
Test Abbreviation:	Test 047			
Start Date:	10/8/2011	Notes:	corrected	Unit A1

				Cond. 2
Start Time:	15:07:29	AC	3:30PM	ESE 0.9
Duration (dd:hh:mm:ss):	0:00:02:08	75	49%	30.32 inHg
Number of points:	4			
Notes:	Test 047			

Statistics	Channel:	Velocity	Flow	T
	Units:	ft/min	cf/m	°F
	Average:	149.5	20.395	69.45
	Minimum:	119	16.21	69.2
	Time of Minimum:	15:09:15	15:09:15	15:09:15
	Date of Minimum:	10/8/2011	10/8/2011	10/8/2011
	Maximum:	181	24.72	69.6
	Time of Maximum:	15:09:27	15:09:27	15:09:27
	Date of Maximum:	10/8/2011	10/8/2011	10/8/2011

Calibration	Sensor:	Velocity	T
	Cal. Date	6/18/2009	6/18/2009

Date	Time	Velocity	Flow	T
MM/dd/yyyy	hh:mm:ss	ft/min	cf/m	°F
10/8/2011	15:09:00	142	19.39	69.2
10/8/2011	15:09:15	119	16.21	69.4
10/8/2011	15:09:27	181	24.72	69.6
10/8/2011	15:09:37	156	21.26	69.6

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