Air Curtains: a Proven Alternative to Vestibule Design

Air Curtain/Air Door technology has been a part of American building design for energy savings since the late 1950's when it was brought to the United States from Europe. The ability of an Air Curtain to reduce energy costs by keeping conditioned air inside of a building and unconditioned air outside when doors are open, with an unobstructed view, plus its ability to provide insect control, is why many engineers choose it for entrance ways, rear door delivery areas, and food service applications.

Sections:

Executive Summary

("Air Doors" and "Air Curtains" are an interchangeable term. For this paper, these units will be referred to as "Air Curtains.")

The purpose of this document is to provide detailed information around the design, operation and quantified performance results of Air Curtains to prove that they are a viable alternative to vestibules.

Detailed analysis has been performed to clearly identify the performance characteristics of Vestibules with and without Air Curtains in a number of building situations and air temperature conditions. These situations are based on field testing, construction models and statistical climatology.

Based on our research findings, Air Curtains (in conjunction with a physical door) are an effective solution to air leakage in the building envelope. *Testing has shown that Air Curtains are more effective than Vestibules in providing environmental separation.* When used in conjunction with a Vestibule, an Air Curtain significantly increases the efficiency of the Vestibule by adding additional protection against climate loss and infiltration of flying insects. Air Curtains provide protection when one or more of the Vestibule doors are open. Air Curtains provide this protection with unobstructed access, both physical and visual, to the building envelope space.

Section 1: GENERAL AIR CURTAIN INFORMATION

An Air Curtain is a device that creates a controlled stream of air and directs it across the full width and height of an opening to create an energy saving air seal. This seal separates different environments, allowing a smooth, unhindered flow of traffic and unobstructed vision through the opening. Because Air Curtains help to contain heated or air conditioned air, they provide sizeable energy savings and personal comfort in both industrial and commercial settings. Additional benefits of using a non-recirculating Air Curtain are that it can be used to repel flying insects and is approved by the food service industry as a means of insect control for customer entry doors, kitchen service and delivery doors (visit http://ars.usda.gov/is/AR/archive/apr07/pests0407.htm for more information). In application, an Air Curtain is not intended to replace a physical door but is intended to serve as an energy savings device by creating an invisible barrier when the physical door is open.

In summation, the Air Curtain produces a coherent sheet of air created by the air stream and the surrounding entrained air. This sheet of air is able to bend and resist thermal exchange over an opening The cabinet design of an Air Curtain allows it to be mounted either on the interior or exterior of a building. Because the air in the surrounding environment is used by the Air Curtain to create the air stream, air quality can influence the mounting location. For this reason, environmental (temperature) separation applications are recommended to only be installed on the interior of a building where the interior conditioned air is utilized to create the air stream.

Air Curtains can be categorized into two types: non-recirculating and recirculating, with three types of installations: horizontal (over a doorway), single vertical (side of doorway) or dual vertical (one on each side of doorway).

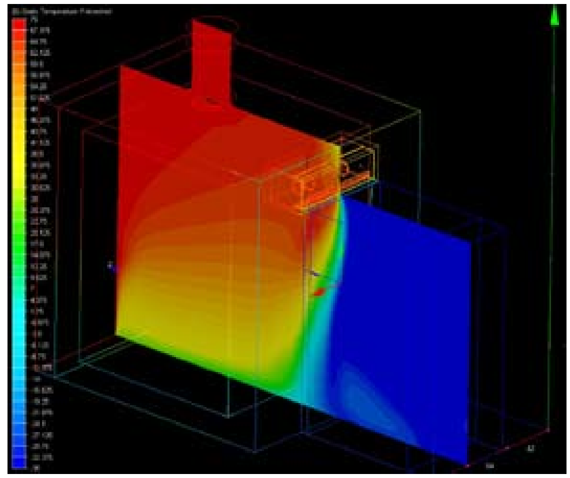


Figure 1 - In this simulation, color depicts temperature. The Air Curtain is providing a barrier, keeping the warm air (red, orange, yellow) inside of the building and the cold air (blue) outside of the building.

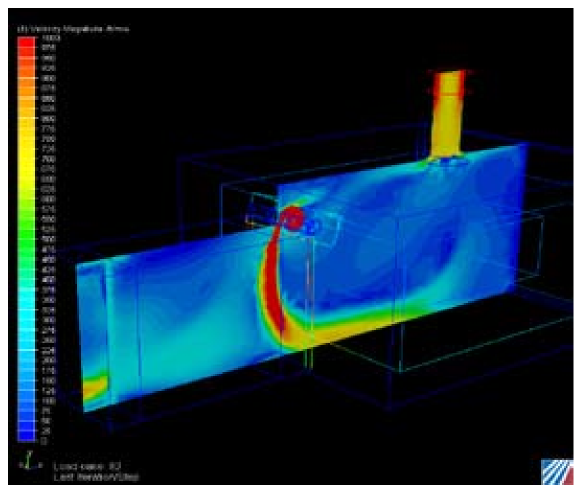


Figure 2 - In this simulation, color depicts velocity. The Air Curtain is providing a high velocity (red) air stream that is able to bend and resist thermal exchange.

Non-Recirculating Air Curtain

1. *Definition:* A non-recirculating Air Curtain is defined as a device that generates and discharges an air stream that is not re-circulated back to the intake. It works

on the function of air stream velocity to counteract thermal exchange, wind loading and the infiltration of insects. To prevent the entry of outside winds, the discharge nozzle in the Air Curtain is angled outward so that the air leaving meets the wind trying to enter the building. For both horizontal and vertical installations, when the wind meets the air stream, it bends back into the building, creating an interior split at the threshold, causing the interior entrained air to flow back into the building and the external entrained air to flow back outside. For proper function, the air stream has to be strong enough to reach the target surface (ground) or opposite air stream and split just inside the doorway.

2. *Construction*: Non-recirculating Air Curtains consist of a structural cabinet housing, an air inlet screen, motor(s), fan(s), a discharge chamber (plenum), air directional vanes, provisions for mounting or securing the unit to the building structure (wall or top-mounting) and optional heating appurtenances (steam, hot water, electric & gas). Non-recirculating Air Curtains are designed and custom fabricated to protect any specific opening and to meet safety standards (See Section 6). There are a number of designs that protect door opening widths, from as small as 24 inches to as large as 192 inches.
3. *Operation:* A non-recirculating Air Curtain installed horizontally on the interior of a building draws indoor conditioned air through an air inlet screen into the fans. The fans pressurize and accelerate the air into the discharge plenum and nozzle, where the air stream is shaped, directed (commonly 15° to the exterior) and discharged. As the air travels towards the floor, non-conditioned, outdoor air plus conditioned, indoor air are entrained onto each side of the unit's air stream. This combined air stream strikes the door's threshold, with a minimum recommended velocity of 800-1000 fpm, and splits into two separate air patterns. One, which can be called the exterior band, contains approximately 20%-30% of the air stream which flows to the outside. The other, which can be called the interior band, contains approximately 70%-80% of the air stream which flows back into the building. The exterior band includes the non-conditioned, entrained, outside air, and the interior band contains the conditioned, entrained, indoor air. Because these bands of air contain both discharged and entrained air, the resulting CFM is more than that originally discharged from the unit. Therefore, there is minimal or no loss of indoor, conditioned air.
4. *Air Performance Testing:* Independent testing and verification of a non-recirculating Air Curtain's performance is essential in order to verify that the equipment meets the minimum velocities for adequate door protection. Non-recirculating Air Curtains must to be tested and certified to ANSI/AMCA Test Standard 220-05 by an independent, third party, i.e. a nationally recognized testing laboratory to prove that the product is performing to the above requirements (See Section 6).

Recirculating Air Curtain

1. *Definition*: A recirculating Air Curtain (sometimes referred to as an air entrance system) is defined as a device that generates and discharges a low velocity, high volume air stream that is captured and recirculated back to the supply fan. It works on the function of air volume to counteract thermal exchange and wind loading. To prevent the entry of outside winds, the discharge nozzle is fixed straight toward the center of a return grill that is approximately 3.5 times the width of the discharge depth. For both horizontal and vertical installations,

when the wind meets the air stream, the air stream bends back toward the building, while still being captured in the return grill. As pressure over the opening fluctuates from slightly positive and negative conditions due to wind load, the air stream moves in and out over the threshold and is still captured in the return grill. Because the air stream is recirculated, the interior entrained air will flow back into the building and the external entrained air will flow back outside. For proper function, the air stream has to be strong enough to reach the return grill but not so strong that it splits like a non-recirculating Air Curtain. The return grill should also have an even draw (low pressure) over the entire surface to facilitate a uniform and stable air stream.

2. *Construction*: Recirculating Air Curtains consist of an air handler, ducting, discharge plenum, straightening media, return grill or grating and optional heating appurtenances (steam, hot water, electric & gas). Recirculating Air Curtains are designed and custom fabricated to meet specific opening requirements and safety standards (See Section 6). There are a number of designs that protect door opening widths, from as small as 8 feet to as large as 32 feet.
3. *Operation:* A recirculating Air Curtain installed horizontally on the interior of a building draws indoor conditioned air through the return grill into the fan. The fan moves air through duct work into the discharge plenum where it is pressurized, shaped and evenly distributed across the discharge nozzle. The air exits the discharge nozzle and travels towards the return grate while maintaining a minimum recommended velocity of 600-800 fpm. [As it approaches the halfway point, this mass of air slows to approximately 600 fpm, but as it approaches the return grate, the air mass speeds up again to approximately 800 fpm due to the draw at the return grate. This observable occurrence is known as the push-pull effect.] Non-conditioned, outdoor air plus conditioned, indoor air are entrained on each side of the unit's air stream. As the air stream strikes the return grate, it splits into three bands; center, interior and exterior. The center band is comprised of the original, straightened air from the discharge plenum that satisfies the demand of the air handler. The exterior band contains all entrained, outdoor, non-conditioned air which flows back to the outside. The interior band contains all of the entrained, indoor, conditioned air which flows back into the building. Because the center band meets the demand of the air handler, the outer bands of entrained air are turned back into their respective environments resulting in minimal or no loss of indoor, conditioned air.

Air Curtain Benefits:

1. *Energy savings* - The energy saved by using Air Curtains can be anywhere from 1%-10%, depending on climate, building size and traffic volume. The energy savings generally pay for the equipment and installation costs within 1-3 years.
2. *Floor space is not compromised* - When Air Curtains are installed above the door, they do not consume valuable floor space or interfere with activity on the floor.
3. *Lower construction costs* - The cost to purchase and install Air Curtains is substantially less than the cost of Vestibule construction.
4. *Uses less supplemental heat* - In areas requiring additional warmth, supplemental heat is often supplied to the Vestibule space with a cabinet unit heater. However, heated Air Curtains can provide the same supplemental heat as a cabinet unit heater yet will run less often, due to the protection against loss of conditioned air that the Air Curtain provides.
5. *Safe, unhindered traffic flow* - Air Curtains

provide protection with unobstructed access, both visual and physical, to the exterior and interior building environment.

6. *Improves sanitation* - Air Curtains reduce the entry of insects (non-recirculating unit), dust and airborne contaminates.
7. *Enhances comfort* - Customers and employees are protected from drafts and HVAC induced temperature fluctuations.
8. *Maintains visibility and safety* - Prevents ice from forming on glass door panels and can dry excess water on floors.

Section 2: FUNCTION OF AIR CURTAINS VS. VESTIBULES

1. When used to prevent air leakage, Air Curtains achieve the same goal of Vestibules. However, because Air Curtains provide a continuous environmental barrier, they prevent the entry of unconditioned, outdoor air more effectively than Vestibules. As floor space is very valuable in commercial buildings, Vestibules are often designed to be so narrow that even single person traffic causes both internal and external doors to be open simultaneously. See Figure 3. For this reason, Vestibules allow unconditioned air, if for only a brief period of time, to enter the building unhindered.

Figure 3

Additionally, when the exterior door(s) open in a Vestibule, unconditioned, outdoor air enters the Vestibule, pressurizing the Vestibule (the amount of air entering is directly related to the outside winds). As the interior door(s) open, the unconditioned air will enter into the facility.

2. Our research is based on neutral building pressure and not on buildings that have a negative or positive building pressure. Negative building pressure has a negative impact, resulting in an increase in infiltration of outside, unconditioned air with an open door or doors. A small positive building pressure has favorable results, as it reduces the infiltration of outside, unconditioned air with Vestibules and Air Curtains; however, a large positive pressure has a negative impact on the energy savings benefit of both Air Curtains and Vestibules because it forces a large amount of conditioned air to leak to the outdoors.

Section 3: DIFFERENCES BETWEEN AIR CURTAINS AND VESTIBULES

1. By definition a Vestibule is a permanent fixture within a building frame. A non-recirculating Air Curtain is a removable/or add-on fixture that does not change the existing structure, and can be easily upgraded, if necessary.
2. Air Curtains differ because they can be installed along with any style of door (self closing, automatic, revolving, rapid roll-up etc.).
3. Air Curtains differ from Vestibules because they eliminate the need for two sets of doors, additional lighting and the space that is being consumed to create the Vestibule.

Section 4: AIR CURTAIN & VESTIBULE PERFORMANCE RESEARCH

(Note: The following research uses non-recirculating Air Curtains.)

To compare the environmental separation performance of a prototypical Vestibule with two parting automatic doors vs. an Air Curtain in conjunction with one parting automatic door, a structured set of Computational Fluid Dynamics (CFD) simulations were performed. CFD analysis was chosen as the test method because of its ability to model moving solids in numerous scenarios, and to allow measurements to be recorded in a multitude of scalar and vector quantities in a precise and repeatable manner that is impossible with simple mathematical equation or physical lab testing procedures. An example of the thermal and vector results provided by CFD analysis can be seen in Figures 4 and 5, where color represents temperature. Under all of the same loads and timing conditions, the Air Curtain in Figure 4 maintains a higher interior temperature (yellow, orange, red) than the vestibule (blue and green indicate lower temperatures) in Figure 5.

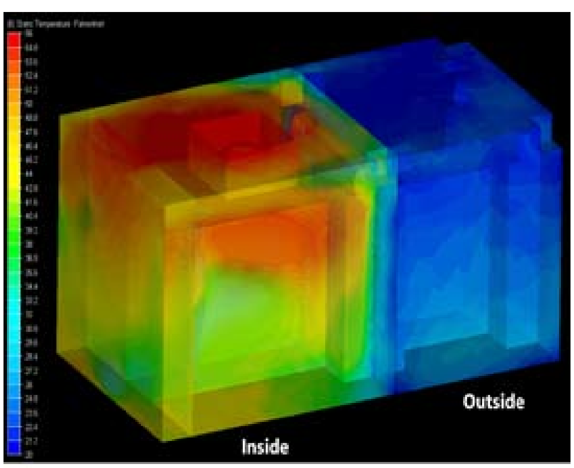


Figure 4 - Color Represents Temperature

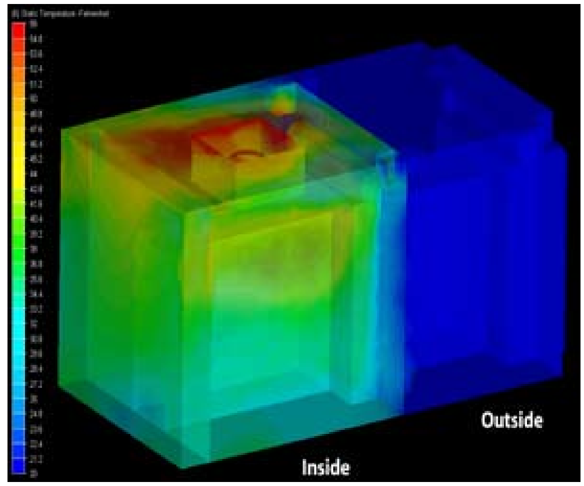


Figure 5 - Color Represents Temperature

The geometry and scale of the test environment was based on the architecture of 3 nationally established pharmacies and 3-D modeled in Solid Works 2007. Detail drawings of the test environment are included in Appendix A. The solid model was saved as a parasolid (.x_t), and it was imported into CF Design v9, a CFD software package developed by Blue Ridge Numerics. The concurrent fluid flow and thermal dynamics simulations used CF Design's unaltered CFD code.

The following three building configurations in a winter temperature scheme placed under different wind loads and traffic timing scenarios were created for the transient (time scale) simulation test program:

A. Vestibule only (see Figure 6)
B. Air Curtain only (see Figure 7)
C. Vestibule and Air Curtain (see Figure 8)

The following four scenarios were created to represent typical entryway conditions:

1. Low Wind, Low Traffic
2. Low Wind, High Traffic
3. High Wind, Low Traffic
4. High Wind, High Traffic

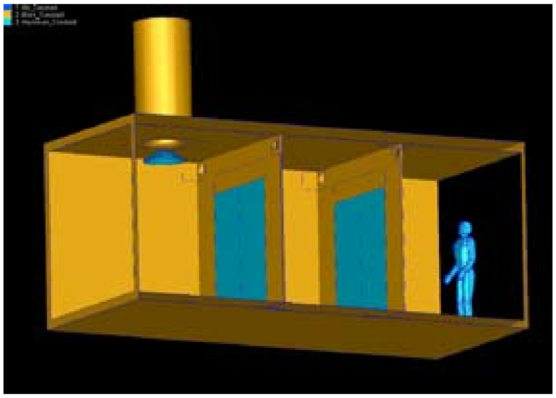


Figure 6 - Vestibule Only

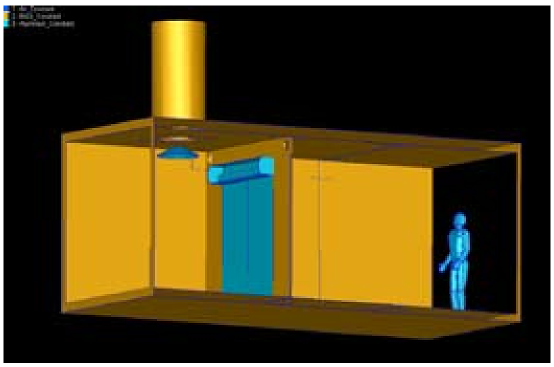


Figure 7 - Air Curtain Only

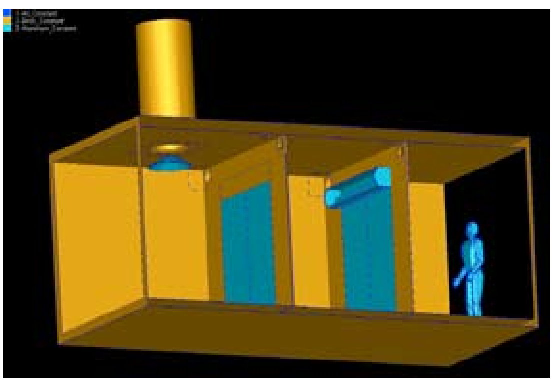


Figure 8 - Vestibule & Air Curtain

The following matrix of twelve simulations resulted when each of the four load and timing scenarios were applied to each of the three building entrance configurations:

A1. Vestibule Only, Low Wind, Low Traffic
A2. Vestibule Only, Low Wind, High Traffic
A3. Vestibule Only, High Wind, Low Traffic
A4. Vestibule Only, High Wind, High Traffic
B1. Air Curtain Only, Low Wind, Low Traffic
B2. Air Curtain Only, Low Wind, High Traffic
B3. Air Curtain Only, High Wind, Low Traffic
B4. Air Curtain Only, High Wind, High Traffic
C1. Vestibule and Air Curtain, Low Wind, Low Traffic
C2. Vestibule and Air Curtain, Low Wind, High Traffic
C3. Vestibule and Air Curtain, High Wind, Low Traffic
C4. Vestibule and Air Curtain, High Wind, High Traffic

All simulations follow the same protocol:

1. All air volumes begin at 20º F, with no differential pressure.
2. The interior airspace is warmed to near room temperature.
3. All air volumes are allowed to normalize after interior airspace heating.
4. Pre door cycle, or initial, interior room temperature readings are recorded.
5. The six foot human (SFH) begins to move toward the exterior automatic parting door.
6. The simulation specific automatic door/Air Curtain cycle occurs as the SFH moves through the Vestibule.
7. The SFH moves into the interior airspace and stops.
8. All airspaces are allowed to normalize.
9. Post door cycle, or final, interior temperature readings are recorded and compared with initial temperature readings, yielding temperature drop, or the final simulation result.

The appendix contains (for all tests) all simulation setup details, the values and positions of all 360 temperature readings, and includes a graphical presentation of linear motions (door and SFH) and the average initial and average final temperatures.

The matrix and bar-graph on the next page summarize the results of all simulations. The matrix displays the specific temperature losses for all building and load combinations, and the bar graph allows direct comparison between building configurations with similar loading. To quantify the temperature loss in the interior airspace, three cutplanes, located parallel to the floor, and positioned 18”, 54”, and 90” above the floor, act as data collection surfaces. Temperature was recorded at 60 evenly spaced points on each of the 3 cutplanes immediately before the first door event (15 seconds into each simulation), and 5 seconds after the last door event. The temperature loss was calculated by the following equation:

$$T_L = [(c18_I+c54_I+c90_I)/3-(c18_F+c54_F+c90_F)/3]$$

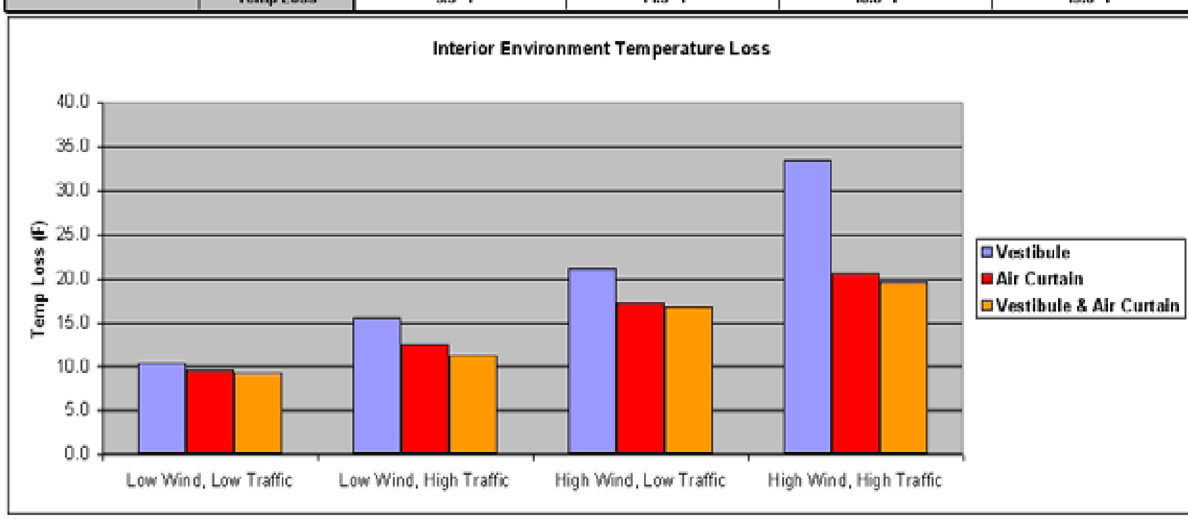
Where:
T_L=Temperature Loss
cX_I= Initial Temperature Value (average of 60 points) on a cutplane located X” above the floor.
cX_F= Final Temperature Value (average of 60 points) on a cutplane located X” above the floor.

Building scenarios that performed best and retained internal airspace heat most effectively will show a smaller temperature loss (T_L) between initial readings and final readings.
To assure accuracy of simulation and analysis results, Blue Ridge Numerics Engineering Services Department evaluated the construction of the underlying 3-D model and set up of the analyses, as well as ran simulations A4 and B4 on their machines. The results of their findings correlate with our findings and are summarized in Appendix C.

Results Summary:
The below graph highlights some differences between building configurations and loading scenarios.

1. When compared with other configurations of similar loading, temperature loss is always highest with the Vestibule scenario, (represented by the blue bar). The Vestibule scenario exhibited 71% higher temperature loss than the Vestibule & Air Curtain scenario under High Wind, High Traffic loading.
2. Building configurations share the same performance order (Vestibule most temperature loss, Vestibule & Air Curtain least temperatue loss) regardless of loading.
3. The load scenario of High Wind, High Traffic yields the highest temperature loss values regardless of building configuration. This load scenario created an average

Analysis Results Summary		Low Wind, Low Traffic	Low Wind, High Traffic	High Wind, Low Traffic	High Wind, High Traffic
Vestibule	Building Scenario	A1	A2	A3	A4
	Temp Loss	10.3 °F	15.5 °F	21.2 °F	33.5 °F
Air Curtain	Building Scenario	B1	B2	B3	B4
	Temp Loss	9.6 °F	12.4 °F	17.3 °F	20.6 °F
Vestibule & Air Curtain	Building Scenario	C1	C2	C3	C4
	Temp Loss	9.3 °F	11.3 °F	16.8 °F	19.6 °F



Temperature Loss Results Graph

temperature drop of 24.6ºF, vs. 9.7ºF for Low Wind, Low Traffic loading.

4. All other things being equal, wind loading has a more pronounced effect on temperature loss than traffic loading.
5. The Vestibule & Air Curtain configuration showed only a small reduction in temperature loss (avg. 5.3%) when compared with the Air Curtain configuration.

Overall, heat retention was positively correlated to building configurations with Air Curtains. Regardless of door timing or wind load, temperature loss was reduced when an Air Curtain was present.

Section 5: FAIL SAFE PERFORMANCE INFORMATION

1. Independent testing (for a listing of testing agencies, see Section 6) ensures that Air Curtains have several safeguards to prevent personal injury. If the unit encounters an electrical short, the entire Air Curtain will shut down and power will be cut, so that no resulting chance of fire will occur. If the unit encounters an overload condition, the unit will shut down automatically until the condition clears.
2. If a physical door fails or the weather seal is compromised and an Air Curtain is installed at an opening, the Air Curtain will protect the opening and prevent energy loss.
3. When power is lost in a building, the Air Curtain will not operate until power is restored. Similarly, if powered, automatic doors fail and must be propped open, the building is unprotected.

Section 6: CERTIFICATION AGENCIES

Safety Testing

There are many organizations currently recognized as Nationally Recognized Testing Laboratories for indoor and outdoor safety performance testing.

Listed below are a few examples of organizations commonly used to evaluate Air Curtains. For a full list, please visit www.osha.gov.

UL Testing/Certification – www.ul.com
Underwriters Laboratories develops and tests to standards to ensure public safety. All units that have been UL tested and approved have the UL mark affixed to each product.

CSA Testing/Certification – www.csa.ca
The Canadian Standards Association develops and tests to standards to ensure public safety. All units that have been CSA tested and approved have the CSA mark affixed to each product.

Intertek Testing/Certification – www.intertek-etlsemko.com
Intertek is the world's largest independent testing, inspection and certification partner. All units that have been Internek tested and approved will have the applicable global market mark (ex. ETL) affixed to each product.

Performance Testing

There are many organizations that are currently recognized by AMCA, NIST, OSHA and other international testing associations for performance testing. Listed below, are a few examples of organizations commonly used to evaluate Air Curtains for performance.

ANSI / AMCA Testing/Certification – www.amca.org
Air Curtains should be tested by an accredited lab and licensed and certified by AMCA, an independent testing agency. All tested and licensed Air Curtains will have the AMCA Certified Performance seal shown on all published product data sheets and the Air Curtain product will also have an AMCA approved label affixed to the

exterior of the Air Curtain cabinet. AMCA (Air Movement and Control Association), located in Arlington Heights, IL, provides independent testing for all types of air moving products. This trade association, in existence since 1917, provides independent ratings that are industry accepted as performance guarantees. A laboratory test standard ANSI/AMCA 220-5 was developed specifically for Air Curtains. The purpose of the standard and the testing of equipment to this standard are to allow manufacturers to have their Air Curtains tested to publish true and actual performances of the Air Curtain devices and also to allow engineers to base product selection using true and accurate data.

1. The power rating (kW) or the efficiency of the operation of the Air Curtain is tested separately.
2. The velocity projection test provides air jet velocities at specified distances from the air outlet of the nozzle.
3. ANSI/AMCA 220-5 does not state how to manufacture Air Curtains. The standard focuses solely on performance.
4. Air Curtain manufacturers that do not have their Air Curtains tested and licensed by an accredited, independent testing agency to the ANSI/AMCA 220-5 standard cannot make any legitimate claims regarding any of their published air performances, especially specific velocities at various distances from the nozzle.

NSF Testing/Certification – www.nsf.org
Air Curtains can be tested and certified by NSF in accordance with NSF/ANSI 37-2005 "Air Curtains for Entranceways in Food and Food Service Establishments." The purpose of the testing is for sanitation reasons, specifically for preventing the entry of flying insects from entering through open doors.

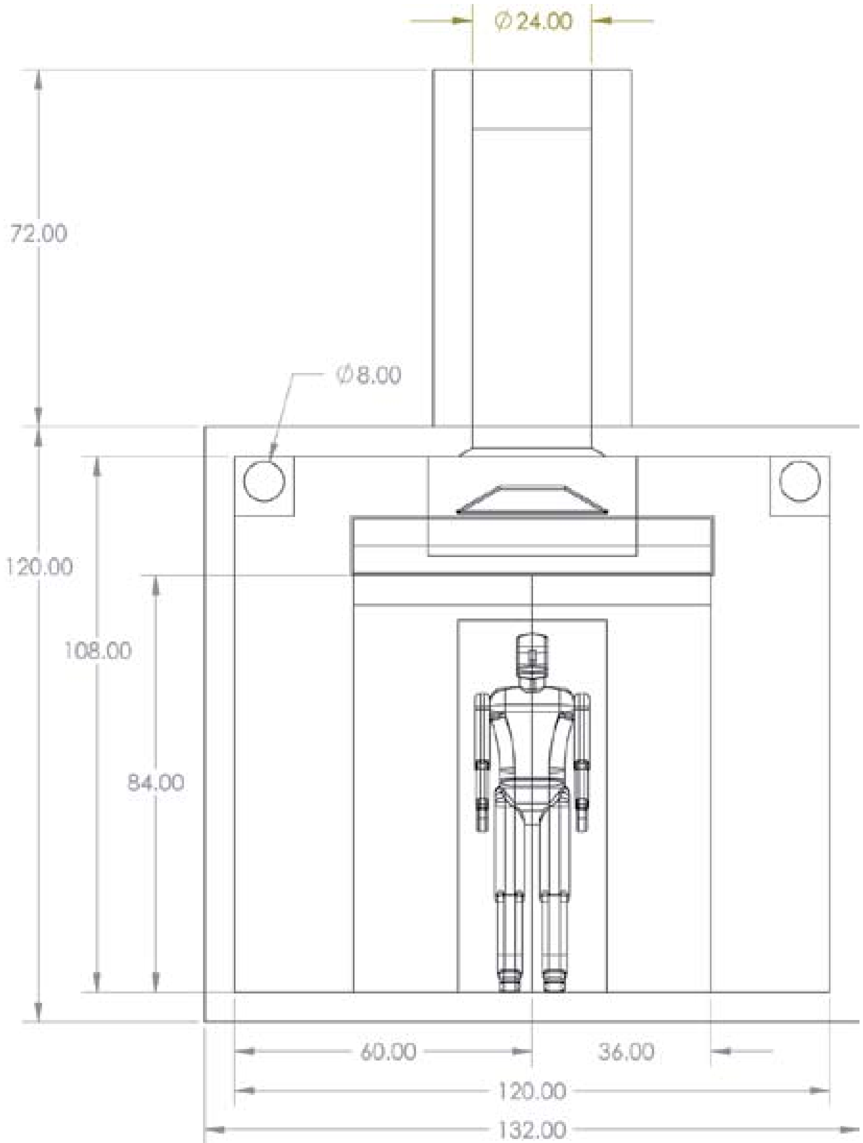
UL Testing/Certification – www.ul.com
Underwriters Laboratories develops and tests to standards to ensure public safety. Air Curtains can be tested and certified by UL in accordance with NSF/ANSI 37-2005 "Air Curtains for Entranceways in Food and Food Service Establishments." All units that have been tested and approved by UL will have the EPH (Environmental & Public Health) mark affixed to each product.

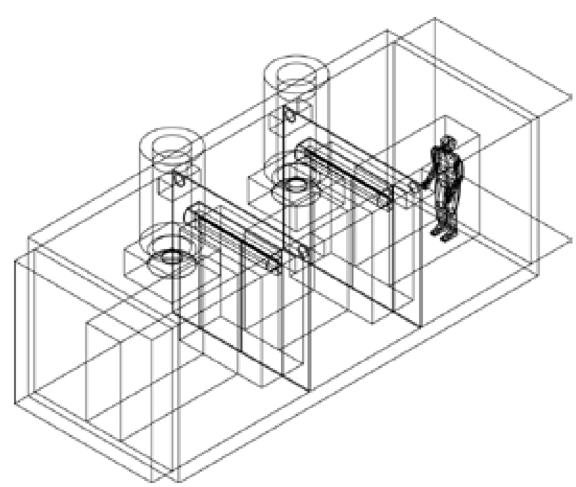
Intertek Testing/Certification – www.intertek-etlsemko.com
Intertek is the world's largest independent testing, inspection and certification partner. Air Curtains can be tested and certified by Intertek in accordance with NSF/ANSI 37-2005 "Air Curtains for Entranceways in Food and Food Service Establishments." All units that have been Intertek tested and approved will have the applicable global market mark (ex. ETL Sanitation) affixed to each product.

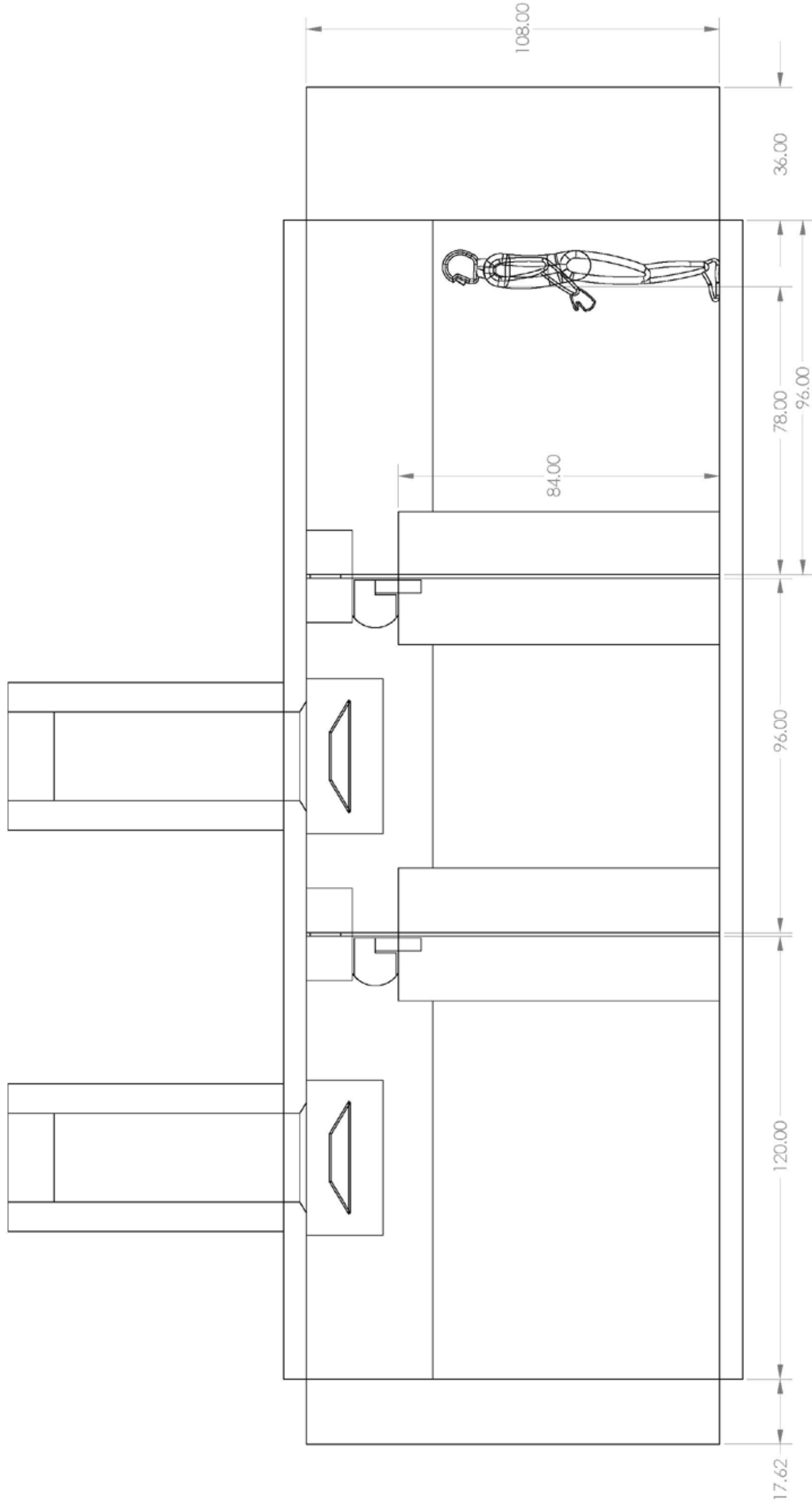
Section 7: CONCLUSION

Based on our research findings, Air Curtains (in conjunction with a physical door) are an effective solution to prevent air leakage in the building envelope. Testing has shown that under identical conditions, a building will experience better environmental separation when using an Air Curtain rather than a Vestibule. This improved environmental separation will create improved energy savings related to heating and air conditioning costs.

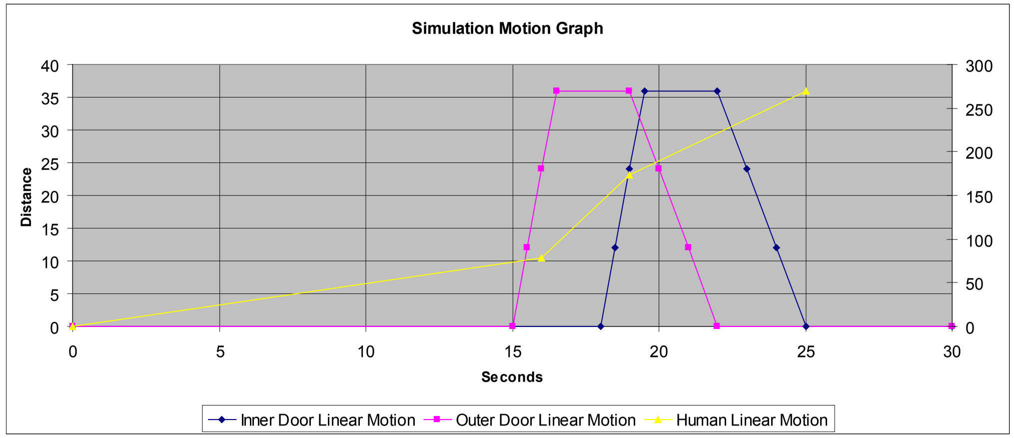
Appendix A - Line Drawings of Test Environment






108.00
36.00
78.00
96.00
84.00
96.00
120.00
17.62

Appendix B - Simulation Setup and Results



SIMULATION A1 (Vestibule, Low Traffic, Low Wind, Winter)			
	Description	Unit	Value
Boundary Condition	Interior Env. Endcap	psi	0
	Exterior Env. Endcap	psi	0
	Exterior Env. Endcap	Deg F	20
	Exterior Env. Endcap(Wind)	fpm	50
	Air Door Discharge (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	psi	0
	HVAC Fan Inlet (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	Deg F	110
Mesh	Building Walls, Diffuser	in	0
	Interior / Exterior Air Space, Endcaps	in	6
	Doorway Airspace, Door, HVAC Fan, Airdoor Cab, Human	in	3
	Airdoor Discharge	in	2
Materials	Building Walls	Brick Constant	
	All Air Volumes, Airdoor Cabinets, HVAC Fan Area	Air Constant	
	Human, Automatic Doors	Aluminum Constant	
Simulation Control	Analysis Mode	Transient	
	Time Step Size	0.05	
	Stop Time	30	
	Save Interval	See Table	
	Flow	Incompressible	
	Heat Transfer	On	
	Advection Scheme	ADV1	

Parameter	Unit	Value
Time Step Size	sec	0.05
Warm up Period	sec	15
Equalization Period	sec	2
Door Open Time	sec	1.5
Door Open Dwell Time	sec	2.5
Door Close Time	sec	3
Inner Door Lag Time	sec	3
Final Equalization Time	sec	5
Person Walking Speed(ft/min)	ft/min	
Non Door Cycle Result Freq	TS	3
Door Cycle Result Freq	TS	0.5

Start Operation TS	Stop Operation TS	Operation Description
0	300	**Interior Warm Up**
300	500	**Door Cycle**
500	600	**Equalization / Results**

HVAC Fan Velocity	Time	fpm
1	0	4000
2	12	4000
3	13	0
4		
5		
6		
7		
8		
9		
10		

Air Door Discharge Velocity	Time	fpm
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Results Output Frequency	Time	Save Freq.
1	0	3
2	15	0.5
3	25	3
4		
5		
6		
7		
8		
9		
10		

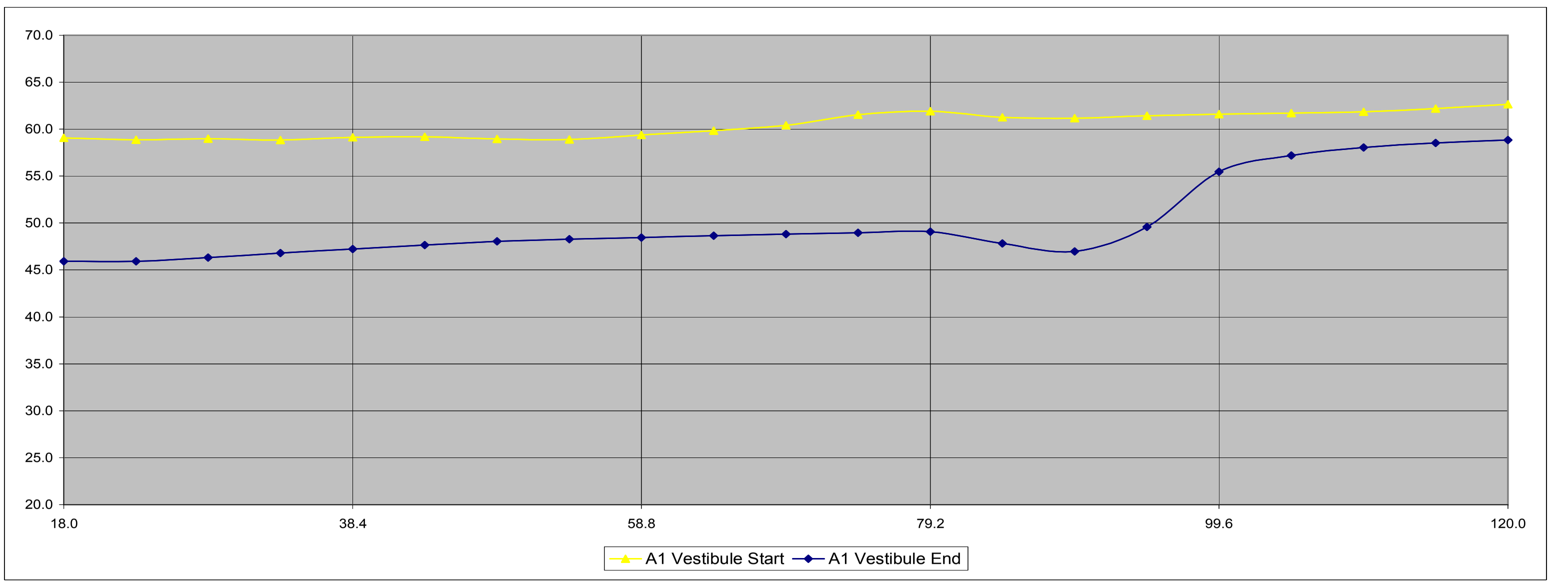
Outer Door Linear Motion	Distance	Time
1	0	0
2	0	15
3	12	15.5
4	24	16
5	36	16.5
6	36	19
7	24	20
8	12	21
9	0	22
10	0	30

Inner Door Linear Motion	Distance	Time
1	0	0
2	0	18
3	12	18.5
4	24	19
5	36	19.5
6	36	22
7	24	23
8	12	24
9	0	25
10	0	30

Human Linear Motion	Distance	Time
1	0	0
2	78	16
3	174	19
4	270	25
5		
6		
7		
8		
9		
10		

A1 Vest LW, LT		A1 Vestibule Start										A1 Vestibule End									
Pt #	Pt Dist Fm Door	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg
		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90	
1	18.0	64.9	64.0	50.6	58.4	50.3	67.0	57.6	59.1	59.7	**59.1**	34.8	48.7	52.5	37.2	49.8	52.3	47.9	39.3	50.7	**45.9**
2	23.1	64.8	62.8	56.0	60.0	50.6	66.1	58.4	52.5	58.7	**58.9**	34.5	49.9	51.3	36.4	51.8	52.7	48.3	38.7	49.9	**45.9**
3	28.2	64.7	61.5	60.9	61.2	50.0	65.2	58.6	51.2	57.8	**59.0**	34.8	50.3	50.1	36.1	52.6	54.2	48.4	39.7	50.5	**46.3**
4	33.3	64.5	61.2	61.8	60.6	49.5	64.1	58.4	52.5	57.0	**58.9**	36.4	50.4	49.1	36.3	52.8	55.0	48.3	41.3	51.5	**46.8**
5	38.4	64.2	62.6	61.9	60.0	49.3	65.6	58.3	53.3	57.0	**59.1**	38.6	50.0	48.1	36.9	53.0	54.6	48.2	42.6	52.8	**47.2**
6	43.5	63.9	64.4	61.8	59.5	49.1	63.8	58.0	54.4	57.7	**59.2**	41.4	49.2	47.3	37.9	53.0	53.7	48.2	44.0	54.1	**47.7**
7	48.6	63.8	65.1	61.7	59.3	49.0	59.6	57.7	55.3	59.1	**59.0**	44.3	47.7	46.5	39.4	52.7	52.7	48.3	45.4	55.4	**48.0**
8	53.7	63.4	64.6	61.5	59.7	49.5	57.7	57.7	55.9	60.3	**58.9**	47.3	45.5	45.9	41.1	52.2	51.5	48.2	46.5	56.3	**48.3**
9	58.8	62.8	62.1	61.3	60.9	53.2	59.3	57.7	56.1	61.0	**59.4**	49.9	43.2	45.5	43.1	51.4	50.4	48.0	47.6	57.0	**48.5**
10	63.9	62.2	60.2	61.1	61.6	56.2	61.3	57.9	56.8	61.3	**59.8**	52.3	41.5	45.5	45.2	50.1	49.2	48.0	48.6	57.4	**48.6**
11	69.0	61.5	60.5	61.0	61.8	57.8	61.8	58.3	59.3	61.7	**60.4**	54.3	40.2	46.1	47.4	48.4	48.3	48.1	49.1	57.5	**48.8**
12	74.1	60.6	61.9	61.1	61.9	59.7	62.1	58.7	65.6	62.2	**61.5**	56.1	38.5	47.5	49.6	45.8	47.8	48.1	49.8	57.4	**49.0**
13	79.2	59.9	62.6	61.2	62.2	60.2	62.1	59.2	66.8	62.9	**61.9**	57.7	35.7	49.6	51.7	42.4	48.0	48.2	51.0	57.3	**49.1**
14	84.3	59.7	62.1	61.3	62.6	60.5	61.2	59.3	60.8	63.7	**61.2**	58.9	28.6	52.1	53.7	30.7	49.2	48.3	51.5	57.3	**47.8**
15	89.4	60.2	61.7	61.3	62.7	60.6	60.0	59.1	60.2	64.7	**61.2**	59.8	24.7	54.7	55.4	20.0	51.3	48.5	51.0	57.4	**47.0**
16	94.5	61.5	62.0	61.3	62.6	60.5	58.7	58.6	62.0	65.8	**61.4**	60.4	40.8	56.9	56.8	20.3	53.8	48.8	50.8	57.6	**49.6**
17	99.6	62.5	62.1	61.2	62.3	60.3	57.8	58.1	63.4	66.9	**61.6**	60.7	55.5	58.6	57.7	52.2	56.0	49.2	51.3	57.9	**55.5**
18	104.7	62.7	62.1	61.1	62.0	60.0	58.6	57.3	63.6	68.0	**61.7**	60.9	59.8	59.7	58.4	57.5	57.7	49.7	52.7	58.3	**57.2**
19	109.8	62.8	62.1	61.0	62.2	59.9	60.3	57.1	62.3	68.9	**61.9**	60.9	60.9	60.4	58.8	59.4	58.8	50.4	54.1	58.6	**58.0**
20	114.9	62.9	62.2	60.9	62.5	59.9	62.6	57.1	62.1	69.6	**62.2**	60.9	61.2	60.7	59.1	60.0	59.6	51.0	55.4	58.9	**58.5**
21	120.0	62.9	62.3	60.8	62.4	59.8	64.9	58.2	62.3	70.1	**62.6**	60.9	61.3	60.9	59.2	60.2	60.0	51.5	56.3	59.2	**58.8**
		60.4										**50.1**									

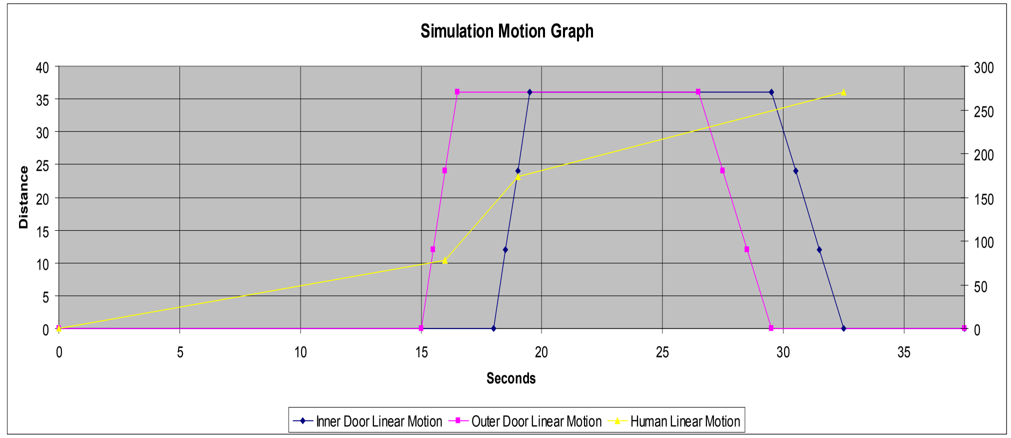
10.3



SIMULATION A2
(Vestibule, High Traffic, Low Wind, Winter)

	Description	Unit	Value
Boundary Condition	Interior Env. Endcap	psi	0
	Exterior Env. Endcap	psi	0
	Exterior Env. Endcap	Deg F	20
	Exterior Env. Endcap(Wind)	fpm	50
	Air Door Discharge (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	psi	0
	HVAC Fan Inlet (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	Deg F	110
Mesh	Building Walls, Diffuser	in	0
	Interior / Exterior Air Space, Endcaps	in	6
	Doorway Airspace, Door, HVAC Fan, Airdoor Cab, Human	in	3
	Airdoor Discharge	in	2
Materials	Building Walls	Brick Constant	
	All Air Volumes, Airdoor Cabinets, HVAC Fan Area	Air Constant	
	Human, Automatic Doors	Aluminum Constant	
Simulation Control	Analysis Mode	Transient	
	Time Step Size	0.05	
	Stop Time	37.5	
	Save Interval	See Table	
	Flow	Incompressible	
	Heat Transfer	On	
	Advection Scheme	ADV1	

Parameter	Unit	Value
Time Step Size	sec	0.05
Warm up Period	sec	15
Equalization Period	sec	2
Door Open Time	sec	1.5
Door Open Dwell Time	sec	10
Door Close Time	sec	3
Inner Door Lag Time	sec	3
Final Equalization Time	sec	5
Person Walking Speed(ft/min)	ft/min	
Non Door Cycle Result Freq	TS	3
Door Cycle Result Freq	TS	0.5



HVAC Fan Velocity	Time	fpm
1	0	4000
2	12	4000
3	13	0
4		
5		
6		
7		
8		
9		
10		

Air Door Discharge Velocity	Time	fpm
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Results Output Frequency	Time	Save Freq
1	0	3
2	15	0.5
3	29.5	3
4		
5		
6		
7		
8		
9		
10		

Start Operation TS	Stop Operation TS	Operation Description
0	300	**Interior Warm Up**
300	650	**Door Cycle**
650	750	**Equalization / Results**

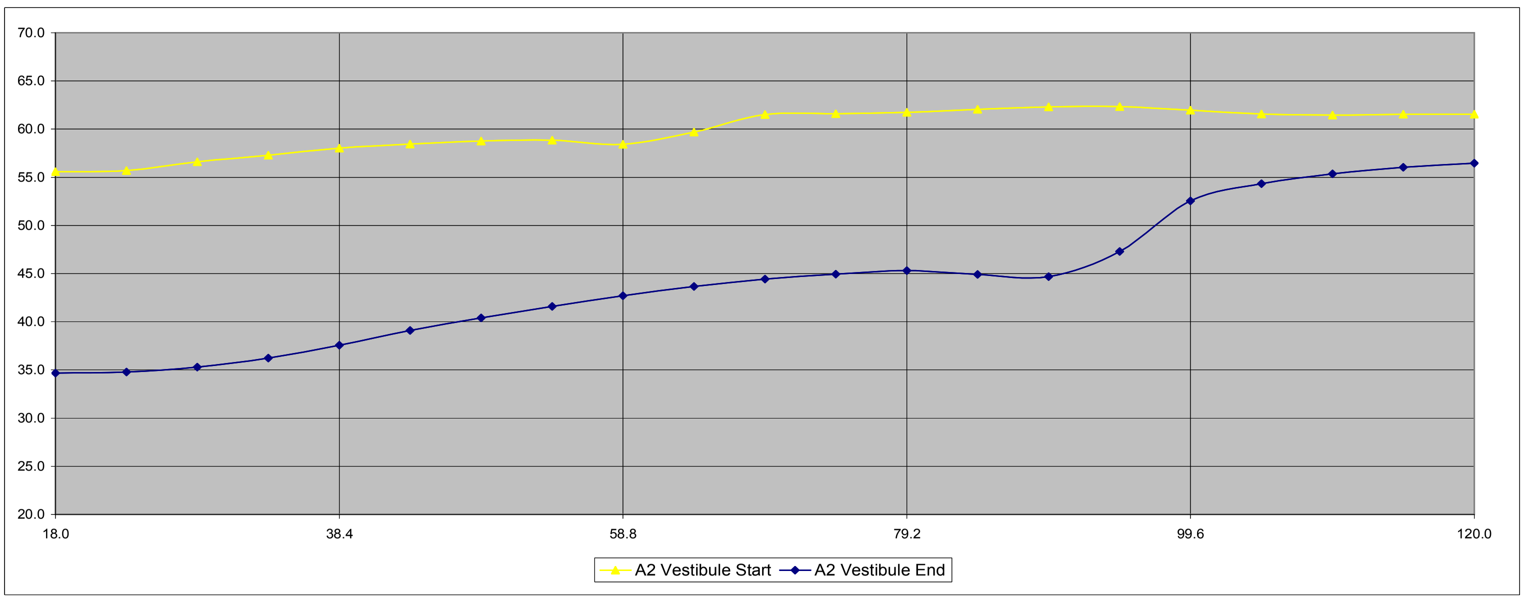
Outer Door Linear Motion	Distance	Time
1	0	0
2	0	15
3	12	15.5
4	24	16
5	36	16.5
6	36	26.5
7	24	27.5
8	12	28.5
9	0	29.5
10	0	37.5

Inner Door Linear Motion	Distance	Time
1	0	0
2	0	18
3	12	18.5
4	24	19
5	36	19.5
6	36	29.5
7	24	30.5
8	12	31.5
9	0	32.5
10	0	37.5

Human Linear Motion	Distance	Time
1	0	0
2	78	16
3	174	19
4	270	32.5
5		
6		
7		
8		
9		
10		

A2 Vest LW, HT		A2 Vestibule Start										A2 Vestibule End									
Pt #	Pt Dist Fm Door	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg
		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90	
1	18.0	63.9	63.0	51.5	60.0	48.7	58.6	56.6	45.4	52.4	**55.6**	24.7	28.4	40.6	30.0	35.6	44.3	31.9	33.9	42.8	**34.7**
2	23.1	63.8	62.5	55.4	61.0	49.9	59.4	56.5	41.7	51.1	**55.7**	26.7	28.2	39.0	31.6	36.8	44.7	32.6	32.8	40.7	**34.8**
3	28.2	63.8	61.1	58.8	61.4	49.4	61.4	56.3	45.1	51.9	**56.6**	30.0	27.8	37.6	33.6	37.3	44.5	33.3	32.7	40.9	**35.3**
4	33.3	63.8	60.1	60.9	61.6	48.2	64.2	56.0	47.4	53.6	**57.3**	35.2	27.2	36.8	36.3	37.4	44.1	34.3	33.2	41.5	**36.2**
5	38.4	63.4	61.3	63.0	61.7	47.2	65.8	56.0	49.0	55.0	**58.0**	41.3	27.9	36.6	39.3	37.3	43.8	35.6	33.9	42.4	**37.6**
6	43.5	63.0	63.8	63.0	61.8	48.2	64.8	55.9	49.9	55.7	**58.5**	46.9	29.7	37.1	42.4	36.9	43.5	37.0	35.0	43.3	**39.1**
7	48.6	62.9	66.2	62.4	61.9	50.6	62.1	55.8	51.2	55.6	**58.8**	51.3	30.1	37.9	45.1	36.5	43.3	38.6	36.7	44.1	**40.4**
8	53.7	62.9	66.5	61.4	62.3	51.4	60.8	56.0	53.8	54.5	**58.8**	54.2	30.9	39.1	47.4	36.1	43.3	40.1	38.2	45.0	**41.6**
9	58.8	63.1	60.9	60.6	62.8	49.7	61.3	56.7	57.5	53.2	**58.4**	56.0	32.7	40.6	49.2	35.9	43.2	41.7	39.2	45.7	**42.7**
10	63.9	63.2	58.5	60.2	63.1	52.0	62.0	57.9	63.8	56.7	**59.7**	57.2	34.2	42.2	50.7	36.0	43.3	43.1	40.0	46.4	**43.7**
11	69.0	63.3	60.4	60.0	63.1	57.7	62.4	58.2	66.5	62.0	**61.5**	58.0	34.3	44.0	51.9	36.0	43.4	44.5	40.6	47.1	**44.4**
12	74.1	63.4	63.1	60.0	63.1	60.0	62.3	58.4	60.3	63.6	**61.6**	58.5	32.8	46.0	53.0	35.8	43.8	45.7	41.2	47.7	**44.9**
13	79.2	63.8	64.7	60.1	62.9	60.9	62.0	58.8	58.0	64.3	**61.7**	58.8	30.2	48.2	54.0	35.1	44.5	46.9	42.0	48.2	**45.3**
14	84.3	64.4	65.1	60.3	62.7	62.5	61.6	59.3	57.9	64.9	**62.1**	59.0	26.5	50.7	55.0	28.2	45.7	47.9	42.5	48.7	**44.9**
15	89.4	65.0	65.3	60.4	62.4	63.4	61.0	59.9	58.0	65.3	**62.3**	59.2	25.0	53.1	55.9	20.0	47.4	48.9	43.3	49.2	**44.7**
16	94.5	65.1	65.2	60.5	62.0	63.5	60.3	60.5	58.2	65.7	**62.3**	59.2	40.9	55.2	56.7	20.4	49.5	49.8	44.3	49.8	**47.3**
17	99.6	63.8	63.7	60.5	61.6	62.8	59.9	60.9	58.5	66.0	**62.0**	59.3	53.7	56.9	57.3	47.7	51.6	50.7	45.5	50.3	**52.5**
18	104.7	62.5	62.2	60.5	61.3	61.8	59.5	61.3	58.7	66.3	**61.6**	59.3	58.0	58.0	57.7	53.3	53.5	51.5	47.1	50.9	**54.3**
19	109.8	62.3	61.6	60.5	61.7	60.9	59.4	61.2	59.0	66.6	**61.5**	59.2	59.3	58.7	58.0	56.0	54.9	52.1	48.6	51.4	**55.4**
20	114.9	62.4	61.5	60.4	62.1	60.3	59.6	61.3	59.2	67.0	**61.5**	59.2	59.8	59.1	58.2	57.3	56.0	52.8	50.0	51.9	**56.0**
21	120.0	62.6	61.6	60.3	61.7	59.9	59.5	61.2	59.5	67.4	**61.5**	59.2	60.0	59.3	58.3	58.0	56.7	53.4	51.1	52.4	**56.5**
		59.9										**44.4**									

15.5



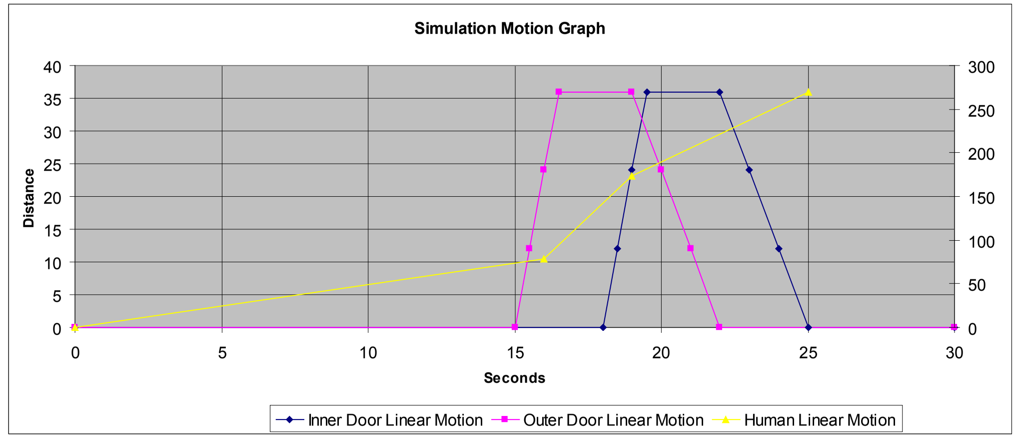
SIMULATION A3

(Vestibule, Low Traffic, High Wind, Winter)

	Description	Unit	Value
Boundary Condition	Interior Env. Endcap	psi	0
	Exterior Env. Endcap	psi	0
	Exterior Env. Endcap	Deg F	20
	Exterior Env. Endcap(Wind)	fpm	352
	Air Door Discharge (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	psi	0
	HVAC Fan Inlet (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	Deg F	110
Mesh	Building Walls, Diffuser	in	0
	Interior / Exterior Air Space, Endcaps	in	6
	Doorway Airspace, Door, HVAC Fan, Airdoor Cab, Human	in	3
	Airdoor Discharge	in	2
Materials	Building Walls	Brick Constant	
	All Air Volumes, Airdoor Cabinets, HVAC Fan Area	Air Constant	
	Human, Automatic Doors	Aluminum Constant	
Simulation Control	Analysis Mode	Transient	
	Time Step Size	0.05	
	Stop Time	30	
	Save Interval	See Table	
	Flow	Incompressible	
	Heat Transfer	On	
	Advection Scheme	ADV1	

Parameter	Unit	Value
Time Step Size	sec	0.05
Warm up Period	sec	15
Equalization Period	sec	2
Door Open Time	sec	1.5
Door Open Dwell Time	sec	2.5
Door Close Time	sec	3
Inner Door Lag Time	sec	3
Final Equalization Time	sec	5
Person Walking Speed(ft/min)	ft/min	
Non Door Cycle Result Freq	TS	3
Door Cycle Result Freq	TS	0.5

Start Operation TS	Stop Operation TS	Operation Description
0	300	**Interior Warm Up**
300	500	**Door Cycle**
500	600	**Equalization / Results**



HVAC Fan Velocity	Time	fpm
1	0	4000
2	12	4000
3	13	0
4		
5		
6		
7		
8		
9		
10		

Air Door Discharge Velocity	Time	fpm
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Results Output Frequency	Time	Save Freq
1	0	3
2	15	0.5
3	25	3
4		
5		
6		
7		
8		
9		
10		

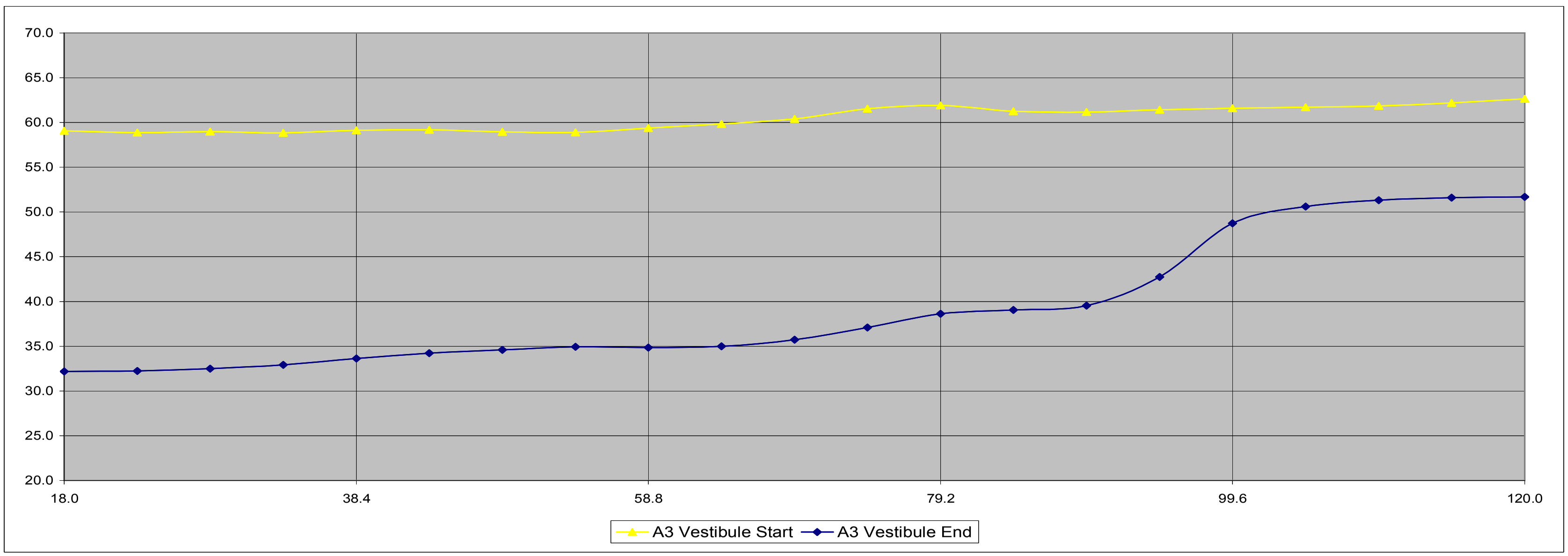
Outer Door Linear Motion	Distance	Time
1	0	0
2	0	15
3	12	15.5
4	24	16
5	36	16.5
6	36	19
7	24	20
8	12	21
9	0	22
10	0	30

Inner Door Linear Motion	Distance	Time
1	0	0
2	0	18
3	12	18.5
4	24	19
5	36	19.5
6	36	22
7	24	23
8	12	24
9	0	25
10	0	30

Human Linear Motion	Distance	Time
1	0	0
2	78	16
3	174	19
4	270	25
5		
6		
7		
8		
9		
10		

A3 Vest HW, LT		A3 Vestibule Start										A3 Vestibule End									
Pt #	Pt Dist Fm Door	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg
		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90	
1	18.0	64.9	64.0	50.6	58.4	50.3	67.0	57.6	59.1	59.7	**59.1**	25.7	24.8	28.8	27.8	29.0	34.0	33.4	42.9	43.3	**32.2**
2	23.1	64.8	62.8	56.0	60.0	50.6	66.1	58.4	52.5	58.7	**58.9**	25.0	25.3	27.9	27.7	30.9	33.8	33.8	42.7	43.0	**32.2**
3	28.2	64.7	61.5	60.9	61.2	50.0	65.2	58.6	51.2	57.8	**59.0**	24.8	25.9	27.4	27.9	32.7	33.8	34.1	42.9	42.8	**32.5**
4	33.3	64.5	61.2	61.8	60.6	49.5	64.1	58.4	52.5	57.0	**58.9**	24.7	26.8	27.5	28.4	34.7	34.0	34.5	43.2	42.6	**32.9**
5	38.4	64.2	62.6	61.9	60.0	49.3	65.6	58.3	53.3	57.0	**59.1**	24.7	28.1	27.8	29.2	36.4	34.2	35.0	44.8	42.3	**33.6**
6	43.5	63.9	64.4	61.8	59.5	49.1	63.8	58.0	54.4	57.7	**59.2**	24.9	29.6	28.4	30.3	37.4	34.5	35.5	45.6	42.0	**34.2**
7	48.6	63.8	65.1	61.7	59.3	49.0	59.6	57.7	55.3	59.1	**59.0**	25.3	30.9	29.1	31.7	37.4	34.9	35.9	44.5	41.7	**34.6**
8	53.7	63.4	64.6	61.5	59.7	49.5	57.7	57.7	55.9	60.3	**58.9**	25.8	31.2	30.0	33.3	36.9	35.3	36.3	44.2	41.4	**34.9**
9	58.8	62.8	62.1	61.3	60.9	53.2	59.3	57.7	56.1	61.0	**59.4**	26.6	31.0	30.9	35.2	36.4	35.9	36.8	39.8	41.0	**34.8**
10	63.9	62.2	60.2	61.1	61.6	56.2	61.3	57.9	56.8	61.3	**59.8**	27.8	30.9	31.8	37.5	36.0	36.9	37.4	36.1	40.5	**35.0**
11	69.0	61.5	60.5	61.0	61.8	57.8	61.8	58.3	59.3	61.7	**60.4**	29.4	31.9	33.0	40.3	35.8	38.5	38.1	34.5	40.2	**35.7**
12	74.1	60.6	61.9	61.1	61.9	59.7	62.1	58.7	65.6	62.2	**61.5**	31.9	34.0	35.0	43.5	36.1	41.1	38.7	33.5	40.0	**37.1**
13	79.2	59.9	62.6	61.2	62.2	60.2	62.1	59.2	66.8	62.9	**61.9**	35.3	34.8	38.2	46.7	36.2	44.2	39.4	32.6	40.1	**38.6**
14	84.3	59.7	62.1	61.3	62.6	60.5	61.2	59.3	60.8	63.7	**61.2**	40.1	32.2	43.0	49.6	27.0	47.5	39.8	32.0	40.4	**39.1**
15	89.4	60.2	61.7	61.3	62.7	60.6	60.0	59.1	60.2	64.7	**61.2**	46.0	26.1	48.6	51.9	20.0	50.2	40.1	32.0	40.7	**39.5**
16	94.5	61.5	62.0	61.3	62.6	60.5	58.7	58.6	62.0	65.8	**61.4**	51.9	39.3	53.7	53.6	20.1	52.4	40.3	32.4	41.2	**42.7**
17	99.6	62.5	62.1	61.2	62.3	60.3	57.8	58.1	63.4	66.9	**61.6**	56.3	52.8	57.2	54.7	48.7	53.8	40.3	33.2	41.7	**48.7**
18	104.7	62.7	62.1	61.1	62.0	60.0	58.6	57.3	63.6	68.0	**61.7**	58.6	57.9	59.0	55.2	53.4	54.8	40.1	34.4	42.1	**50.6**
19	109.8	62.8	62.1	61.0	62.2	59.9	60.3	57.1	62.3	68.9	**61.9**	59.3	59.5	59.7	55.5	54.7	55.3	39.9	35.4	42.5	**51.3**
20	114.9	62.9	62.2	60.9	62.5	59.9	62.6	57.1	62.1	69.6	**62.2**	59.3	59.9	60.0	55.6	55.1	55.7	39.6	36.5	42.7	**51.6**
21	120.0	62.9	62.3	60.8	62.4	59.8	64.9	58.2	62.3	70.1	**62.6**	59.2	60.0	60.1	55.6	55.1	55.9	39.2	37.4	42.8	**51.7**
		60.4										**39.2**									

21.2

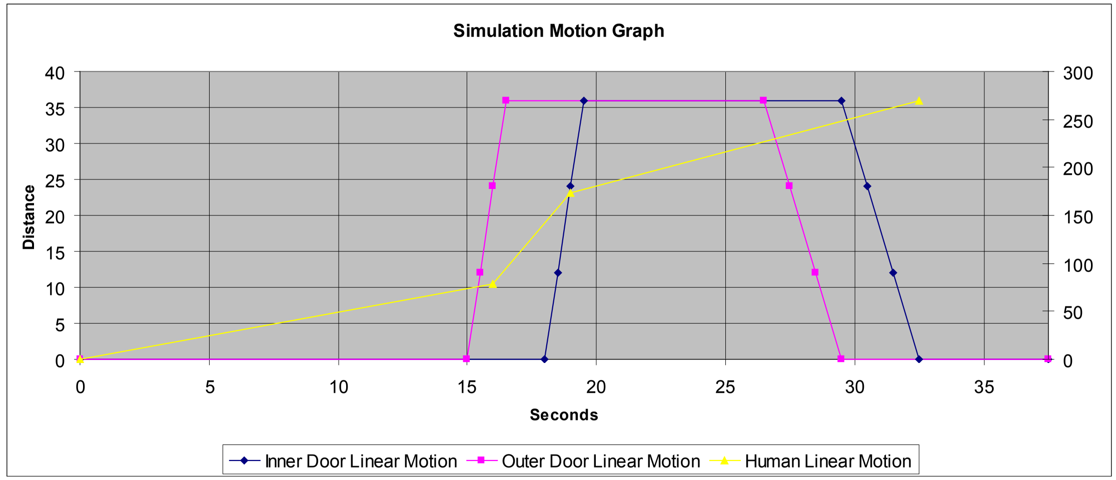


SIMULATION A4

(Vestibule, High Traffic, High Wind, Winter)

	Description	Unit	Value
Boundary Condition	Interior Env. Endcap	psi	0
	Exterior Env. Endcap	psi	0
	Exterior Env. Endcap	Deg F	20
	Exterior Env. Endcap(Wind)	fpm	352
	Air Door Discharge (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	psi	0
	HVAC Fan Inlet (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	Deg F	110
Mesh	Building Walls, Diffuser	in	0
	Interior / Exterior Air Space, Endcaps	in	6
	Doorway Airspace, Door, HVAC Fan, Airdoor Cab, Human	in	3
	Airdoor Discharge	in	2
Materials	Building Walls	Brick Constant	
	All Air Volumes, Airdoor Cabinets, HVAC Fan Area	Air Constant	
	Human, Automatic Doors	Aluminum Constant	
Simulation Control	Analysis Mode	Transient	
	Time Step Size	0.05	
	Stop Time	37.5	
	Save Interval	See Table	
	Flow	Incompressible	
	Heat Transfer	On	
	Advection Scheme	ADV1	

Parameter	Unit	Value
Time Step Size	sec	0.05
Warm up Period	sec	15
Equalization Period	sec	2
Door Open Time	sec	1.5
Door Open Dwell Time	sec	10
Door Close Time	sec	3
Inner Door Lag Time	sec	3
Final Equalization Time	sec	5
Person Walking Speed(ft/min)	ft/min	
Non Door Cycle Result Freq	TS	3
Door Cycle Result Freq	TS	0.5



HVAC Fan Velocity	Time	fpm
1	0	4000
2	12	4000
3	13	0
4		
5		
6		
7		
8		
9		
10		

Air Door Discharge Velocity	Time	fpm
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Results Output Frequency	Time	Save Freq.
1	0	3
2	15	0.5
3	29.5	3
4		
5		
6		
7		
8		
9		
10		

Start Operation TS	Stop Operation TS	Operation Description
0	300	**Interior Warm Up**
300	650	**Door Cycle**
650	750	**Equalization / Results**

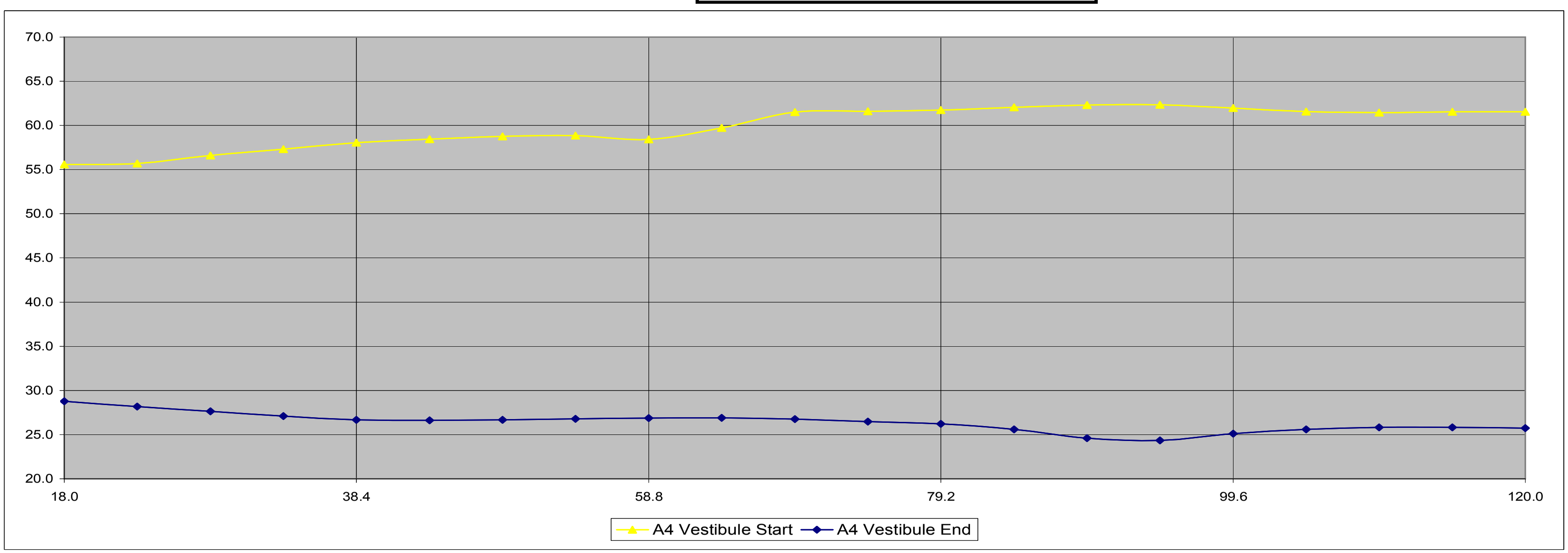
Outer Door Linear Motion	Distance	Time
1	0	0
2	0	15
3	12	15.5
4	24	16
5	36	16.5
6	36	26.5
7	24	27.5
8	12	28.5
9	0	29.5
10	0	37.5

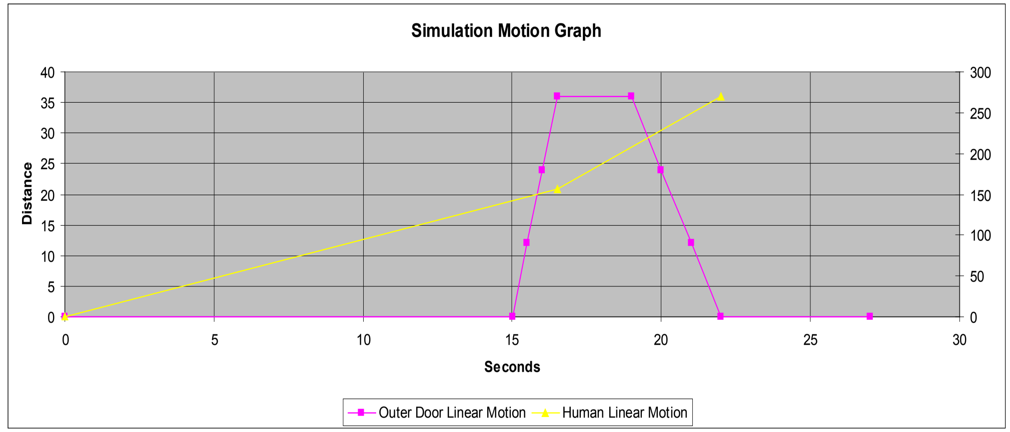
Inner Door Linear Motion	Distance	Time
1	0	0
2	0	18
3	12	18.5
4	24	19
5	36	19.5
6	36	29.5
7	24	30.5
8	12	31.5
9	0	32.5
10	0	37.5

Human Linear Motion	Distance	Time
1	0	0
2	78	16
3	174	19
4	270	32.5
5		
6		
7		
8		
9		
10		

A4 Vest HW, HT		A4 Vestibule Start										A4 Vestibule End									
Pt #	Pt Dist Fm Door	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg
		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90	
1	18.0	63.9	63.0	51.5	60.0	48.7	58.6	56.6	45.4	52.4	**55.6**	30.3	24.9	28.1	24.5	28.6	25.8	30.0	37.6	29.1	**28.8**
2	23.1	63.8	62.5	55.4	61.0	49.9	59.4	56.5	41.7	51.1	**55.7**	30.0	25.6	27.9	24.7	26.8	26.0	28.3	36.6	27.6	**28.2**
3	28.2	63.8	61.1	58.8	61.4	49.4	61.4	56.3	45.1	51.9	**56.6**	29.7	26.2	27.6	25.0	24.5	26.2	27.5	35.2	26.9	**27.6**
4	33.3	63.8	60.1	60.9	61.6	48.2	64.2	56.0	47.4	53.6	**57.3**	29.3	26.7	27.4	25.3	23.2	26.6	27.3	31.4	26.7	**27.1**
5	38.4	63.4	61.3	63.0	61.7	47.2	65.8	56.0	49.0	55.0	**58.0**	29.0	27.2	27.2	25.7	23.0	27.0	27.3	27.0	26.7	**26.7**
6	43.5	63.0	63.8	63.0	61.8	48.2	64.8	55.9	49.9	55.7	**58.5**	28.7	27.7	27.1	25.9	23.4	27.3	27.4	25.3	26.9	**26.6**
7	48.6	62.9	66.2	62.4	61.9	50.6	62.1	55.8	51.2	55.6	**58.8**	28.4	28.2	27.0	26.1	24.2	27.4	27.5	24.4	26.9	**26.7**
8	53.7	62.9	66.5	61.4	62.3	51.4	60.8	56.0	53.8	54.5	**58.8**	28.1	28.6	27.0	26.3	25.4	27.5	27.5	23.9	26.8	**26.8**
9	58.8	63.1	60.9	60.6	62.8	49.7	61.3	56.7	57.5	53.2	**58.4**	27.8	29.0	26.9	26.3	27.1	27.5	27.3	23.4	26.6	**26.9**
10	63.9	63.2	58.5	60.2	63.1	52.0	62.0	57.9	63.8	56.7	**59.7**	27.5	29.3	26.8	26.3	28.3	27.5	26.8	23.1	26.6	**26.9**
11	69.0	63.3	60.4	60.0	63.1	57.7	62.4	58.2	66.5	62.0	**61.5**	27.2	29.3	26.7	26.2	28.9	27.6	25.8	22.9	26.3	**26.7**
12	74.1	63.4	63.1	60.0	63.1	60.0	62.3	58.4	60.3	63.6	**61.6**	26.9	29.2	26.5	26.1	28.8	27.7	24.4	22.5	26.1	**26.5**
13	79.2	63.8	64.7	60.1	62.9	60.9	62.0	58.8	58.0	64.3	**61.7**	26.7	29.0	26.5	26.0	28.3	27.9	23.4	22.3	25.8	**26.2**
14	84.3	64.4	65.1	60.3	62.7	62.5	61.6	59.3	57.9	64.9	**62.1**	26.6	28.6	26.5	25.8	24.1	28.1	22.9	22.2	25.4	**25.6**
15	89.4	65.0	65.3	60.4	62.4	63.4	61.0	59.9	58.0	65.3	**62.3**	26.5	24.4	26.8	25.6	20.0	28.3	22.7	22.1	25.0	**24.6**
16	94.5	65.1	65.2	60.5	62.0	63.5	60.3	60.5	58.2	65.7	**62.3**	26.4	22.1	27.7	25.4	20.0	28.3	22.7	22.0	24.5	**24.3**
17	99.6	63.8	63.7	60.5	61.6	62.8	59.9	60.9	58.5	66.0	**62.0**	26.4	24.8	28.7	25.3	24.1	28.1	22.6	21.9	24.1	**25.1**
18	104.7	62.5	62.2	60.5	61.3	61.8	59.5	61.3	58.7	66.3	**61.6**	26.4	27.8	30.0	25.5	24.6	27.8	22.6	21.8	23.9	**25.6**
19	109.8	62.3	61.6	60.5	61.7	60.9	59.4	61.2	59.0	66.6	**61.5**	26.6	29.3	30.8	25.6	24.6	27.3	22.7	21.7	23.6	**25.8**
20	114.9	62.4	61.5	60.4	62.1	60.3	59.6	61.3	59.2	67.0	**61.5**	27.0	29.4	31.3	25.8	24.4	26.7	22.8	21.7	23.5	**25.8**
21	120.0	62.6	61.6	60.3	61.7	59.9	59.5	61.2	59.5	67.4	**61.5**	27.6	29.1	30.9	25.8	24.1	26.1	22.9	21.6	23.4	**25.7**
		59.9										**26.4**									

33.5





SIMULATION B1
(Air Door, Low Traffic, Low Wind, Winter)

	Description	Unit	Value
Boundary Condition	Interior Env. Endcap	psi	0
	Exterior Env. Endcap	Deg F	20
	Exterior Env. Endcap(Wind)	fpm	50
	Air Door Discharge (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	Deg F	110
Mesh	Building Walls	in	0
	Interior / Exterior Air Space, Endcaps	in	6
	Doorway Airspace, Door, HVAC Fan, Airdoor Cab, Human Motionpath	in	3
	Airdoor Discharge	in	2
Materials	Building Walls, Diffuser	Brick Constant	
	All Air Volumes, HVAC Fan Area, Exterior Vestibule Wall, Exterior Air Door, Exterior Doors	Air Constant	
	Interior Airdoor Cabinet, Interior Auto Doors, Human	Aluminum Constant	
Simulation Control	Analysis Mode	Transient	
	Time Step Size	0.05	
	Stop Time	27	
	Save Interval	See Table	
	Flow	Incompressible	
	Heat Transfer	On	
	Advection Scheme	ADV1	

Parameter	Unit	Value
Time Step Size	sec	0.05
Warm up Period (Incl Eq Per)	sec	15
Equalization Period	sec	2
Door Open Time	sec	1.5
Door Open Dwell Time	sec	2.5
Door Close Time	sec	3
Inner Door Lag Time	sec	0
Final Equalization Time	sec	5
Person Walking Speed(ft/min)	ft/min	
Non Door Cycle Result Freq	sec	3
Door Cycle Result Freq	sec	0.5

Start Operation TS	Stop Operation TS	Operation Description
0	300	**Interior Warm Up**
300	440	**Door Cycle**
440	540	**Equalization / Results**

HVAC Fan Velocity	Time	fpm
1	0	4000
2	12	4000
3	13	0
4		
5		
6		
7		
8		
9		
10		

Air Door Discharge Velocity	Time	fpm
1	0	0
2	13	0
3	13.5	5000
4	24	5000
5	24.5	0
6		
7		
8		
9		
10		

Results Output Frequency	Time	Save Freq
1	0	3
2	15	0.5
3	22	3
4		
5		
6		
7		
8		
9		
10		

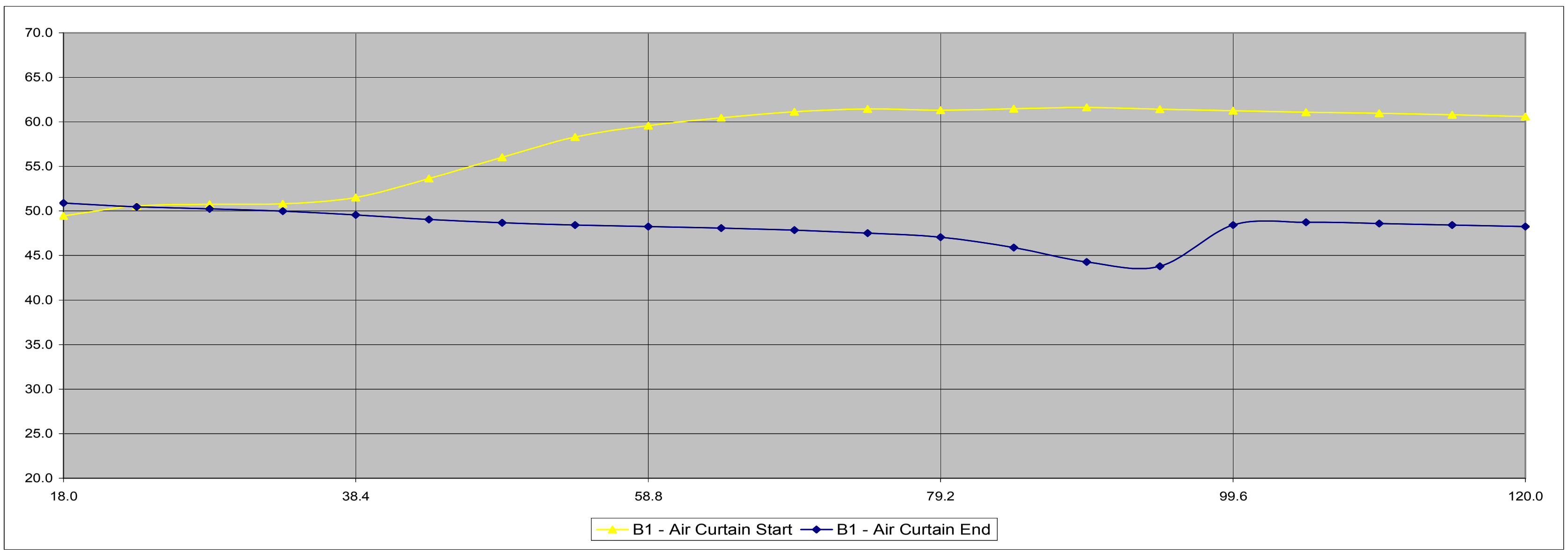
Outer Door Linear Motion	Distance	Time
1	0	0
2	0	15
3	12	15.5
4	24	16
5	36	16.5
6	36	19
7	24	20
8	12	21
9	0	22
10	0	27

Inner Door Linear Motion	Distance	Time
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Human Linear Motion	Distance	Time
1	0	0
2	156	16.5
3	270	22
4		
5		
6		
7		
8		
9		
10		

B1 Air Curtain LW, LT		B1 - Air Curtain Start										B1 - Air Curtain End									
Pt #	Pt Dist Fm Door	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg
		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90	
1	18.0	62.7	59.2	52.5	40.8	37.3	49.5	57.2	37.1	48.6	**49.4**	46.2	44.0	53.5	50.4	54.0	54.6	49.6	53.1	52.6	**50.9**
2	23.1	62.8	56.6	50.7	55.0	37.6	46.0	57.7	37.4	51.1	**50.5**	46.1	41.6	53.2	50.2	52.8	54.7	49.4	54.8	51.6	**50.5**
3	28.2	62.6	53.0	52.5	59.1	36.6	44.3	57.6	38.0	53.2	**50.8**	45.9	40.1	52.9	50.0	51.4	54.8	49.1	56.9	51.1	**50.3**
4	33.3	62.1	48.8	56.5	59.7	34.8	43.0	57.4	39.7	55.1	**50.8**	45.9	38.9	52.7	49.8	49.8	54.8	48.9	57.8	51.1	**50.0**
5	38.4	61.5	44.5	61.2	60.0	33.9	45.5	57.4	43.4	56.4	**51.5**	45.9	37.7	52.5	49.6	48.3	54.8	48.8	57.1	51.4	**49.6**
6	43.5	60.7	43.7	62.6	60.5	35.2	56.9	57.5	48.8	56.9	**53.7**	45.7	36.5	52.2	49.3	46.9	54.7	48.8	55.9	51.6	**49.1**
7	48.6	59.8	48.3	63.6	60.9	40.0	64.1	57.8	52.6	57.0	**56.0**	45.5	35.9	51.9	49.1	45.4	54.6	48.8	55.2	51.8	**48.7**
8	53.7	59.4	55.0	63.5	61.2	48.2	66.4	58.2	55.5	57.2	**58.3**	45.3	36.3	51.6	48.9	43.8	54.4	48.8	54.9	51.8	**48.4**
9	58.8	59.6	60.9	62.7	61.6	52.6	66.2	58.6	57.1	57.2	**59.6**	45.1	37.7	51.2	48.7	42.1	54.1	48.8	54.7	51.8	**48.2**
10	63.9	60.0	61.9	61.9	61.9	58.6	64.8	58.9	58.9	57.1	**60.5**	44.9	39.4	50.8	48.4	40.3	53.8	48.8	54.5	51.8	**48.1**
11	69.0	60.6	62.6	61.3	62.2	61.8	63.5	58.9	61.4	58.0	**61.1**	44.6	40.9	50.3	48.2	38.5	53.4	48.6	54.3	51.9	**47.8**
12	74.1	61.2	62.8	60.9	62.5	64.2	63.0	58.8	60.3	59.6	**61.5**	44.4	41.8	49.7	47.9	36.6	53.0	48.4	54.0	51.9	**47.5**
13	79.2	61.6	61.8	60.5	62.7	64.9	62.8	58.7	57.7	61.3	**61.3**	44.1	42.2	49.1	47.6	33.8	52.5	48.2	54.0	52.0	**47.1**
14	84.3	62.0	62.2	60.1	62.8	64.9	62.5	58.8	56.3	63.8	**61.5**	43.9	41.0	48.5	47.3	26.1	52.1	48.0	54.1	52.1	**45.9**
15	89.4	62.4	62.1	59.8	62.9	64.5	61.9	58.8	56.3	65.8	**61.6**	43.7	34.0	47.9	46.9	20.0	51.7	47.8	54.1	52.2	**44.3**
16	94.5	62.4	60.4	59.7	62.9	63.9	61.3	58.9	56.3	67.0	**61.4**	43.5	30.6	47.5	46.6	20.4	51.3	47.7	54.2	52.3	**43.8**
17	99.6	62.0	60.2	59.6	62.8	63.3	60.5	59.0	56.5	67.5	**61.3**	43.4	42.2	47.0	46.3	51.8	51.0	47.5	54.2	52.3	**48.4**
18	104.7	61.6	60.3	59.7	62.7	62.7	59.8	58.7	56.7	67.5	**61.1**	43.3	44.8	46.4	46.0	53.4	50.7	47.4	54.3	52.4	**48.7**
19	109.8	61.6	60.5	59.8	62.5	62.1	59.4	58.8	56.9	67.1	**61.0**	43.2	44.4	46.2	45.8	53.4	50.5	47.2	54.3	52.3	**48.6**
20	114.9	61.7	60.8	60.0	62.4	61.3	58.8	58.6	57.0	66.6	**60.8**	43.2	43.7	45.9	45.5	53.3	50.4	47.1	54.3	52.2	**48.4**
21	120.0	61.7	61.1	60.2	62.5	60.5	58.4	57.8	57.2	66.0	**60.6**	43.1	42.9	45.7	45.4	53.3	50.3	47.1	54.4	52.1	**48.3**
		57.8										48.2									

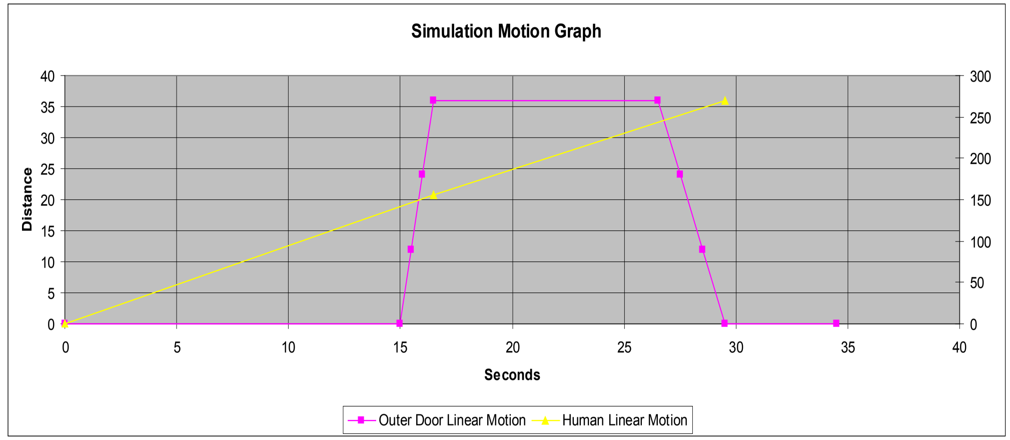
9.6



SIMULATION B2
(Air Door, High Traffic, Low Wind, Winter)

	Description	Unit	Value
Boundary Condition	Interior Env. Endcap	psi	0
	Exterior Env. Endcap	Deg F	20
	Exterior Env. Endcap(Wind)	fpm	50
	Air Door Discharge (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	Deg F	110
Mesh	Building Walls	in	0
	Interior / Exterior Air Space, Endcaps	in	6
	Doorway Airspace, Door, HVAC Fan, Airdoor Cab, Human Motionpath	in	3
	Airdoor Discharge	in	2
Materials	Building Walls	Brick Constant	
	All Air Volumes, HVAC Fan Area, Exterior Vestibule Wall, Exterior Air Door, Exterior Doors	Air Constant	
	Interior Airdoor Cabinet, Interior Auto Doors, Human	Aluminum Constant	
Simulation Control	Analysis Mode	Transient	
	Time Step Size	0.05	
	Stop Time	34.5	
	Save Interval	See Table	
	Flow	Incompressible	
	Heat Transfer	On	
	Advection Scheme	ADV1	

Parameter	Unit	Value
Time Step Size	sec	0.05
Warm up Period (Incl Eq Per)	sec	15
Equalization Period	sec	2
Door Open Time	sec	1.5
Door Open Dwell Time	sec	10
Door Close Time	sec	3
Inner Door Lag Time	sec	0
Final Equalization Time	sec	5
Person Walking Speed(ft/min)	ft/min	
Non Door Cycle Result Freq	sec	3
Door Cycle Result Freq	sec	1



Start Operation TS	Stop Operation TS	Operation Description
0	300	**Interior Warm Up**
300	590	**Door Cycle**
590	690	**Equalization / Results**

HVAC Fan Velocity	Time	fpm
1	0	4000
2	12	4000
3	13	0
4		
5		
6		
7		
8		
9		
10		

Air Door Discharge Velocity	Time	fpm
1	0	0
2	13	0
3	13.5	5000
4	31.5	5000
5	32	0
6		
7		
8		
9		
10		

Results Output Frequency	Time	Save Freq
1	0	3
2	15	1
3	29.5	3
4		
5		
6		
7		
8		
9		
10		

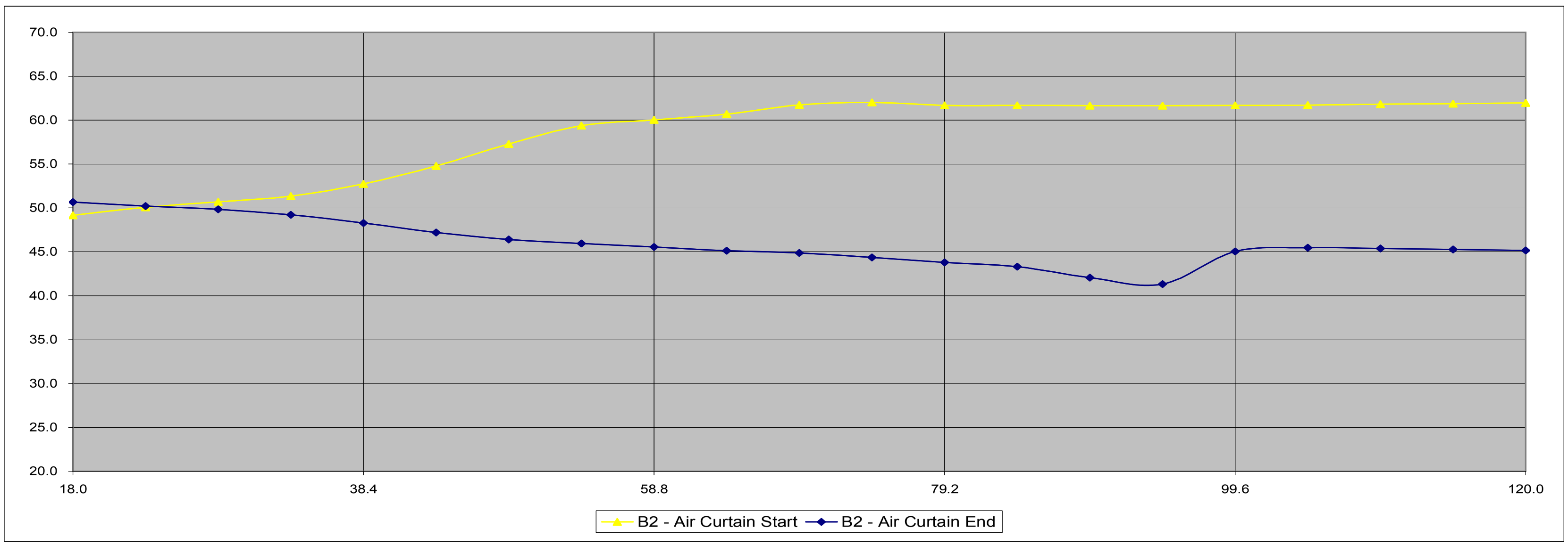
Outer Door Linear Motion	Distance	Time
1	0	0
2	0	15
3	12	15.5
4	24	16
5	36	16.5
6	36	26.5
7	24	27.5
8	12	28.5
9	0	29.5
10	0	34.5

Inner Door Linear Motion	Distance	Time
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Human Linear Motion	Distance	Time
1	0	0
2	156	16.5
3	270	29.5
4		
5		
6		
7		
8		
9		
10		

B2 Air Curtain LW, HT		B2 - Air Curtain Start										B2 - Air Curtain End									
		LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)				LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			
Pt #	Pt Dist Fm Door	X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90	Avg	X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90	Avg
1	18.0	62.1	55.8	54.2	38.1	37.9	43.5	58.2	38.4	54.2	**49.2**	46.6	45.4	49.9	50.4	52.3	52.2	52.4	54.8	52.1	**50.7**
2	23.1	63.0	53.4	48.2	50.8	37.9	42.9	61.0	37.0	56.6	**50.1**	45.6	43.5	49.5	49.9	50.4	51.8	51.9	56.7	52.5	**50.2**
3	28.2	63.3	49.9	45.1	59.3	36.6	42.7	63.1	36.7	59.4	**50.7**	44.6	41.9	49.0	49.5	48.4	51.3	51.4	59.8	52.8	**49.9**
4	33.3	62.7	45.5	48.6	62.3	35.0	45.0	64.1	36.6	62.3	**51.3**	43.6	40.7	48.5	49.0	45.9	50.7	50.9	60.5	53.0	**49.2**
5	38.4	61.4	44.4	54.3	63.8	34.2	52.3	64.4	36.2	63.6	**52.7**	43.0	39.9	48.0	48.5	42.7	50.0	50.6	58.6	53.1	**48.3**
6	43.5	60.1	50.3	58.6	64.3	36.0	58.3	64.5	37.3	63.8	**54.8**	42.7	39.3	47.5	47.9	38.8	49.3	50.3	55.9	53.1	**47.2**
7	48.6	59.3	56.0	61.4	65.2	42.2	63.1	64.5	39.9	63.9	**57.3**	42.5	38.8	46.9	47.1	35.9	48.7	50.0	54.5	53.2	**46.4**
8	53.7	59.2	60.5	61.9	66.6	51.2	64.5	64.6	42.0	64.1	**59.4**	42.3	38.4	46.5	46.4	35.0	48.1	49.8	54.2	53.2	**46.0**
9	58.8	59.6	61.6	61.2	67.5	52.7	63.1	64.8	45.5	64.3	**60.0**	42.0	38.0	46.0	45.6	34.2	47.5	49.5	53.8	53.2	**45.6**
10	63.9	60.3	61.9	60.4	67.6	56.1	61.1	65.2	48.9	64.6	**60.7**	41.8	37.8	45.5	45.0	33.1	47.1	49.2	53.5	53.2	**45.1**
11	69.0	61.0	62.5	59.9	67.2	62.3	60.4	65.6	51.8	64.8	**61.7**	41.5	37.8	45.0	44.5	33.1	46.7	48.8	53.2	53.3	**44.9**
12	74.1	61.5	61.4	59.5	65.3	64.3	60.0	66.3	54.9	64.9	**62.0**	41.2	38.0	44.4	44.2	30.5	46.4	48.4	53.0	53.3	**44.4**
13	79.2	61.5	60.6	59.3	61.4	64.1	59.4	66.6	57.3	65.0	**61.7**	40.9	38.3	43.9	43.8	26.9	46.3	48.0	52.9	53.3	**43.8**
14	84.3	61.6	60.5	59.0	61.2	63.7	58.9	66.6	58.5	65.0	**61.7**	40.5	38.0	43.4	43.5	24.3	46.1	47.5	52.9	53.3	**43.3**
15	89.4	61.7	60.4	58.9	62.2	63.3	58.5	66.6	58.1	65.0	**61.6**	40.2	32.6	43.0	43.2	20.0	46.1	47.1	52.9	53.3	**42.1**
16	94.5	61.8	60.4	58.9	62.9	63.0	58.2	66.4	58.5	65.1	**61.7**	40.0	26.3	42.7	43.0	21.0	46.1	46.8	52.8	53.3	**41.3**
17	99.6	61.9	60.4	58.9	63.0	62.5	57.9	66.4	59.0	65.1	**61.7**	39.7	34.0	42.5	42.7	47.8	46.0	46.5	52.8	53.3	**45.0**
18	104.7	62.0	60.4	59.1	63.3	62.0	57.8	66.1	59.6	65.2	**61.7**	39.5	37.3	42.3	42.4	49.4	46.0	46.2	52.8	53.3	**45.5**
19	109.8	62.0	60.6	59.3	63.5	61.5	57.7	66.2	60.3	65.4	**61.8**	39.4	37.5	42.3	42.1	49.4	45.9	45.8	52.8	53.3	**45.4**
20	114.9	62.0	60.8	59.4	63.6	61.0	57.6	66.0	61.0	65.4	**61.9**	39.3	37.1	42.2	41.9	49.3	45.8	45.7	52.8	53.3	**45.3**
21	120.0	62.0	61.0	59.6	63.7	60.6	57.6	66.0	61.3	65.8	**62.0**	39.2	36.7	42.2	41.7	49.2	45.7	45.5	52.8	53.3	**45.2**
		58.4										45.9									

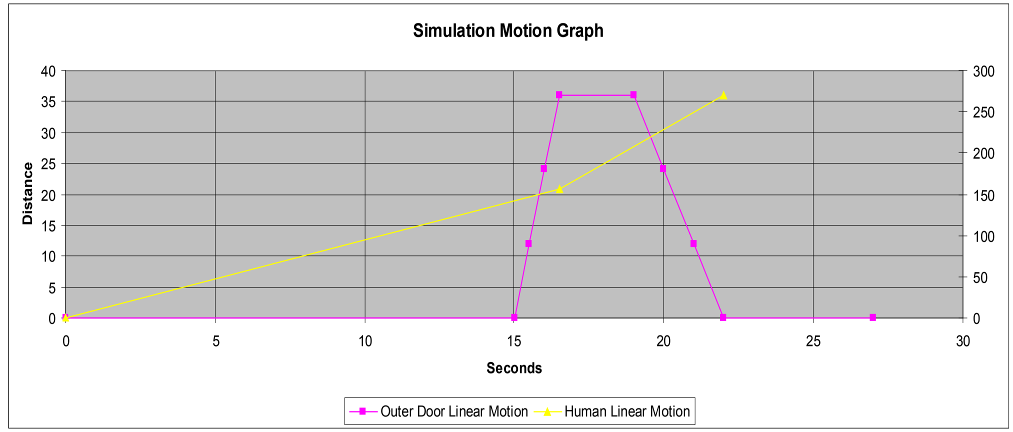
12.4



SIMULATION B3
(Air Door, Low Traffic, High Wind, Winter)

	Description	Unit	Value
Boundary Condition	Interior Env. Endcap	psi	0
	Exterior Env. Endcap	Deg F	20
	Exterior Env. Endcap(Wind)	fpm	352
	Air Door Discharge (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	Deg F	110
Mesh	Building Walls	in	0
	Interior / Exterior Air Space, Endcaps	in	6
	Doorway Airspace, Door, HVAC Fan, Airdoor Cab, Human Motionpath	in	3
	Airdoor Discharge	in	2
Materials	Building Walls, Diffuser		Brick Constant
	All Air Volumes, HVAC Fan Area, Exterior Vestibule Wall, Exterior Air Door, Exterior Doors		Air Constant
	Interior Airdoor Cabinet, Interior Auto Doors, Human		Aluminum Constant
Simulation Control	Analysis Mode		Transient
	Time Step Size		0.05
	Stop Time		27
	Save Interval		See Table
	Flow		Incompressible
	Heat Transfer		On
	Advection Scheme		ADV1

Parameter	Unit	Value
Time Step Size	sec	0.05
Warm up Period (Incl Eq Per)	sec	15
Equalization Period	sec	2
Door Open Time	sec	1.5
Door Open Dwell Time	sec	2.5
Door Close Time	sec	3
Inner Door Lag Time	sec	0
Final Equalization Time	sec	5
Person Walking Speed(ft/min)	ft/min	
Non Door Cycle Result Freq	sec	3
Door Cycle Result Freq	sec	0.5



HVAC Fan Velocity	Time	fpm
1	0	4000
2	12	4000
3	13	0
4		
5		
6		
7		
8		
9		
10		

Air Door Discharge Velocity	Time	fpm
1	0	0
2	13	0
3	13.5	5000
4	24	5000
5	24.5	0
6		
7		
8		
9		
10		

Results Output Frequency	Time	Save Freq
1	0	3
2	15	0.5
3	22	3
4		
5		
6		
7		
8		
9		
10		

Start Operation TS	Stop Operation TS	Operation Description
0	300	**Interior Warm Up**
300	440	**Door Cycle**
440	540	**Equalization / Results**

Outer Door Linear Motion	Distance	Time
1	0	0
2	0	15
3	12	15.5
4	24	16
5	36	16.5
6	36	19
7	24	20
8	12	21
9	0	22
10	0	27

Inner Door Linear Motion	Distance	Time
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Human Linear Motion	Distance	Time
1	0	0
2	156	16.5
3	270	22
4		
5		
6		
7		
8		
9		
10		

B3 Air Curtain HW, LT

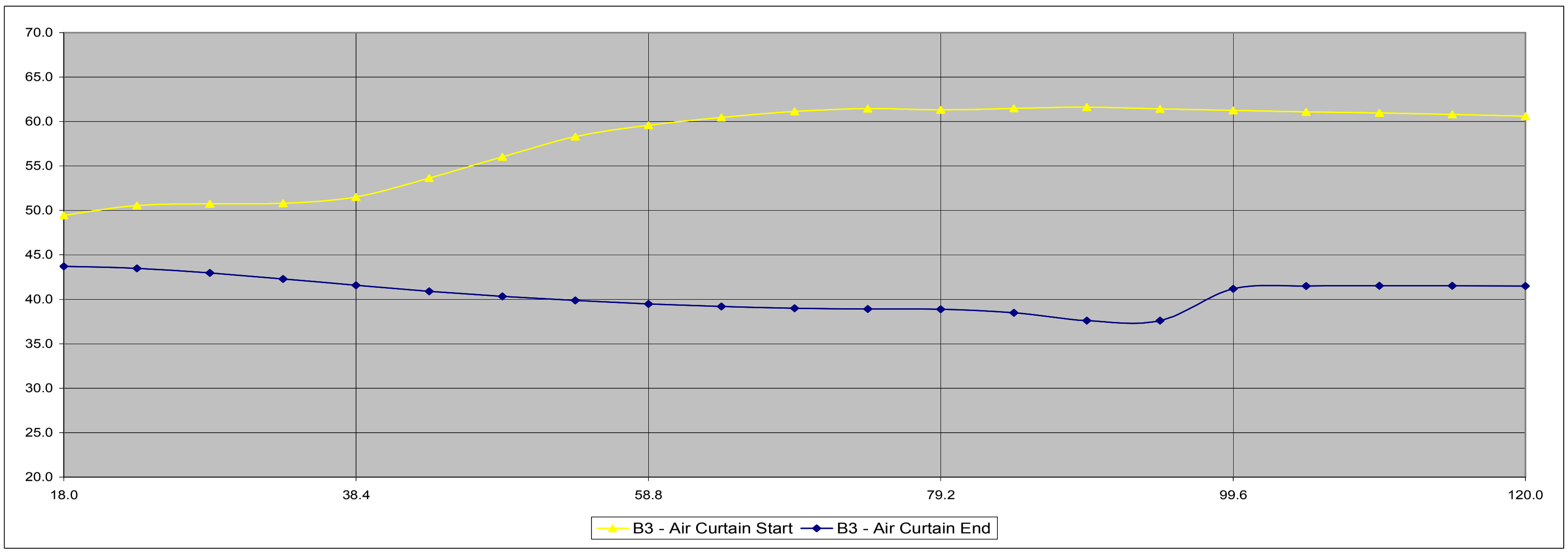
B3 - Air Curtain Start

Pt #	Pt Dist Fm Door	LEFT (40,X,18 to 40,X,120) X=18	X=54	X=90	CENTER (0,X,18 to 0,X,120) X=18	X=54	X=90	RIGHT (-40,X,18 to -40,X,120) X=18	X=54	X=90	Avg
1	18.0	62.7	59.2	52.5	40.8	37.3	49.5	57.2	37.1	48.6	**49.4**
2	23.1	62.8	56.6	50.7	55.0	37.6	46.0	57.7	37.4	51.1	**50.5**
3	28.2	62.6	53.0	52.5	59.1	36.6	44.3	57.6	38.0	53.2	**50.8**
4	33.3	62.1	48.8	56.5	59.7	34.8	43.0	57.4	39.7	55.1	**50.8**
5	38.4	61.5	44.5	61.2	60.0	33.9	45.5	57.4	43.4	56.4	**51.5**
6	43.5	60.7	43.7	62.6	60.5	35.2	56.9	57.5	48.8	56.9	**53.7**
7	48.6	59.8	48.3	63.6	60.9	40.0	64.1	57.8	52.6	57.0	**56.0**
8	53.7	59.4	55.0	63.5	61.2	48.2	66.4	58.2	55.5	57.2	**58.3**
9	58.8	59.6	60.9	62.7	61.6	52.6	66.2	58.6	57.1	57.2	**59.6**
10	63.9	60.0	61.9	61.9	61.9	58.6	64.8	58.9	58.9	57.1	**60.5**
11	69.0	60.6	62.6	61.3	62.2	61.8	63.5	58.9	61.4	58.0	**61.1**
12	74.1	61.2	62.8	60.9	62.5	64.2	63.0	58.8	60.3	59.6	**61.5**
13	79.2	61.6	61.8	60.5	62.7	64.9	62.8	58.7	57.7	61.3	**61.3**
14	84.3	62.0	62.2	60.1	62.8	64.9	62.5	58.8	56.3	63.8	**61.5**
15	89.4	62.4	62.1	59.8	62.9	64.5	61.9	58.8	56.3	65.8	**61.6**
16	94.5	62.4	60.4	59.7	62.9	63.9	61.3	58.9	56.3	67.0	**61.4**
17	99.6	62.0	60.2	59.6	62.8	63.3	60.5	59.0	56.5	67.5	**61.3**
18	104.7	61.6	60.3	59.7	62.7	62.7	59.8	58.7	56.7	67.5	**61.1**
19	109.8	61.6	60.5	59.8	62.5	62.1	59.4	58.8	56.9	67.1	**61.0**
20	114.9	61.7	60.8	60.0	62.4	61.3	58.8	58.6	57.0	66.6	**60.8**
21	120.0	61.7	61.1	60.2	62.5	60.5	58.4	57.8	57.2	66.0	**60.6**
						57.8					

B3 - Air Curtain End

Pt #	Pt Dist Fm Door	LEFT (40,X,18 to 40,X,120) X=18	X=54	X=90	CENTER (0,X,18 to 0,X,120) X=18	X=54	X=90	RIGHT (-40,X,18 to -40,X,120) X=18	X=54	X=90	Avg
1	18.0	39.1	39.9	43.8	41.2	40.8	47.4	40.8	46.6	53.8	**43.7**
2	23.1	38.9	39.1	43.6	40.8	39.6	46.6	40.6	47.4	54.9	**43.5**
3	28.2	38.7	38.2	43.2	40.5	38.3	45.9	40.3	47.9	53.5	**43.0**
4	33.3	38.6	37.5	43.0	40.2	37.0	45.4	39.9	47.8	51.4	**42.3**
5	38.4	38.4	36.8	42.6	39.9	35.5	44.9	39.6	47.2	49.2	**41.6**
6	43.5	38.2	36.0	42.3	39.7	33.9	44.6	39.5	46.7	47.3	**40.9**
7	48.6	38.0	35.3	42.0	39.4	32.3	44.2	39.3	46.3	46.0	**40.3**
8	53.7	37.8	34.7	41.7	39.3	30.8	44.0	39.1	46.2	45.3	**39.9**
9	58.8	37.7	34.4	41.4	39.2	29.3	43.7	38.9	46.1	44.8	**39.5**
10	63.9	37.6	34.2	41.1	39.1	28.1	43.5	38.8	46.0	44.4	**39.2**
11	69.0	37.7	33.9	40.7	39.1	27.4	43.3	38.7	45.8	44.2	**39.0**
12	74.1	37.8	33.7	40.5	39.2	27.7	43.1	38.5	45.7	44.1	**38.9**
13	79.2	37.9	33.6	40.4	39.3	27.8	43.0	38.2	45.7	44.1	**38.9**
14	84.3	38.0	33.6	40.3	39.4	24.3	42.8	38.1	45.7	44.2	**38.5**
15	89.4	38.0	29.8	40.2	39.6	20.0	42.7	38.0	45.8	44.4	**37.6**
16	94.5	38.0	29.4	40.1	39.6	20.3	42.6	38.2	45.8	44.6	**37.6**
17	99.6	37.9	38.1	40.0	39.5	43.2	42.5	38.8	45.8	44.9	**41.2**
18	104.7	37.8	39.3	39.9	39.6	44.2	42.3	39.3	45.9	45.2	**41.5**
19	109.8	37.6	38.9	39.9	39.5	44.2	42.1	40.1	45.9	45.4	**41.5**
20	114.9	37.5	38.5	39.9	39.4	44.2	42.0	40.5	45.9	45.7	**41.5**
21	120.0	37.4	38.0	39.9	39.4	44.2	42.0	40.8	46.0	45.9	**41.5**
						40.5					

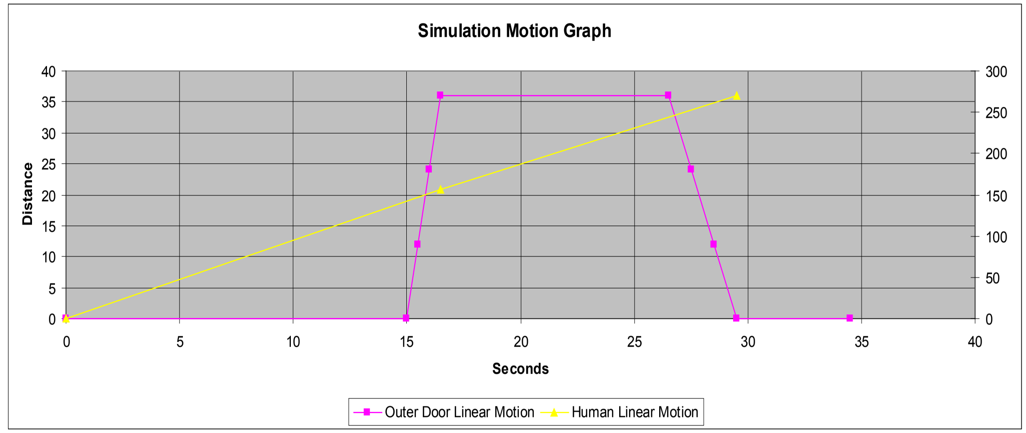
17.3



SIMULATION B4
(Air Door, High Traffic, High Wind, Winter)

	Description	Unit	Value
Boundary Condition	Interior Env. Endcap	psi	0
	Exterior Env. Endcap	Deg F	20
	Exterior Env. Endcap(Wind)	fpm	352
	Air Door Discharge (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	Deg F	110
Mesh	Building Walls	in	0
	Interior / Exterior Air Space, Endcaps	in	6
	Doorway Airspace, Door, HVAC Fan, Airdoor Cab, Human Motionpath	in	3
	Airdoor Discharge	in	2
Materials	Building Walls	Brick Constant	
	All Air Volumes, HVAC Fan Area, Exterior Vestibule Wall, Exterior Air Door, Exterior Doors	Air Constant	
	Interior Airdoor Cabinet, Interior Auto Doors, Human	Aluminum Constant	
Simulation Control	Analysis Mode	Transient	
	Time Step Size	0.05	
	Stop Time	34.5	
	Save Interval	See Table	
	Flow	Incompressible	
	Heat Transfer	On	
	Advection Scheme	ADV1	

Parameter	Unit	Value
Time Step Size	sec	0.05
Warm up Period (Incl Eq Per)	sec	15
Equalization Period	sec	2
Door Open Time	sec	1.5
Door Open Dwell Time	sec	10
Door Close Time	sec	3
Inner Door Lag Time	sec	0
Final Equalization Time	sec	5
Person Walking Speed(ft/min)	ft/min	
Non Door Cycle Result Freq	sec	3
Door Cycle Result Freq	sec	1



Start Operation TS	Stop Operation TS	Operation Description
0	300	**Interior Warm Up**
300	590	**Door Cycle**
590	690	**Equalization / Results**

HVAC Fan Velocity	Time	fpm
1	0	4000
2	12	4000
3	13	0
4		
5		
6		
7		
8		
9		
10		

Air Door Discharge Velocity	Time	fpm
1	0	0
2	13	0
3	13.5	5000
4	31.5	5000
5	32	0
6		
7		
8		
9		
10		

Results Output Frequency	Time	Save Freq
1	0	3
2	15	1
3	29.5	3
4		
5		
6		
7		
8		
9		
10		

Outer Door Linear Motion	Distance	Time
1	0	0
2	0	15
3	12	15.5
4	24	16
5	36	16.5
6	36	26.5
7	24	27.5
8	12	28.5
9	0	29.5
10	0	34.5

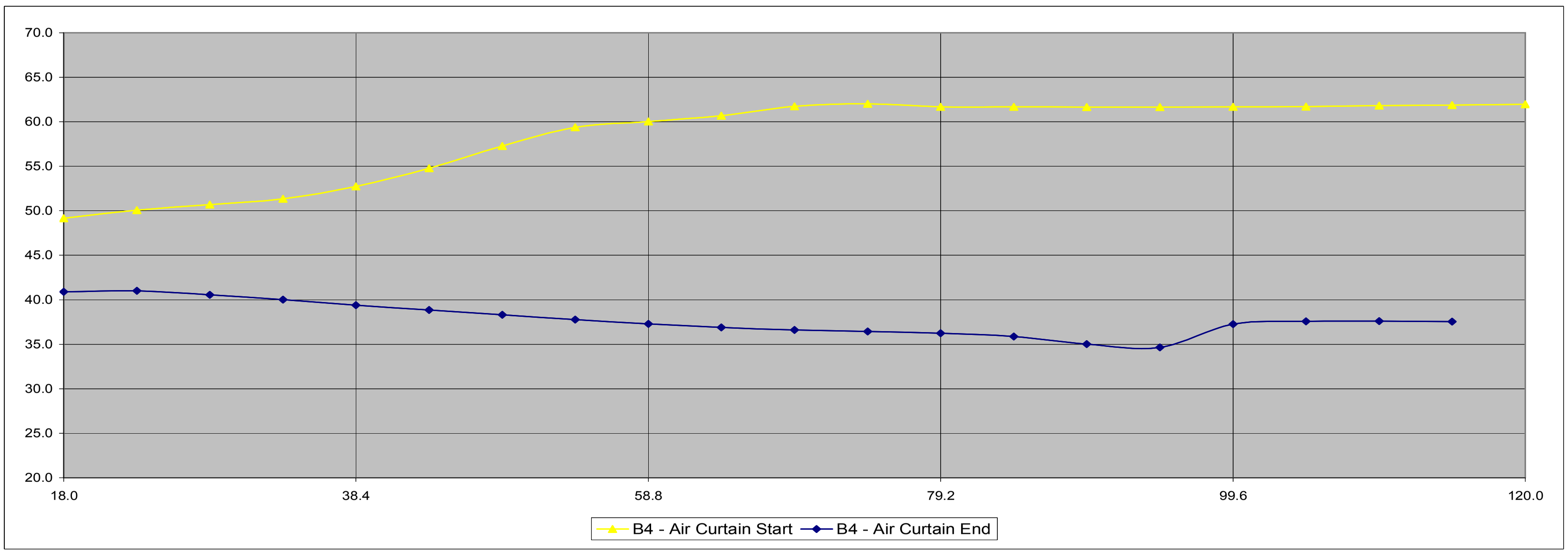
Inner Door Linear Motion	Distance	Time
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Human Linear Motion	Distance	Time
1	0	0
2	156	16.5
3	270	29.5
4		
5		
6		
7		
8		
9		
10		

B4 Air Curtain HW, HT

Pt #	Pt Dist Fm Door	B4 - Air Curtain Start										B4 - Air Curtain End									
		LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg
		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90	
1	18.0	62.1	55.8	54.2	38.1	37.9	43.5	58.2	38.4	54.2	**49.2**	37.6	36.3	39.9	39.1	36.1	43.0	41.4	48.1	46.3	**40.9**
2	23.1	63.0	53.4	48.2	50.8	37.9	42.9	61.0	37.0	56.6	**50.1**	37.6	36.0	39.9	38.8	35.0	42.8	41.7	48.0	49.3	**41.0**
3	28.2	63.3	49.9	45.1	59.3	36.6	42.7	63.1	36.7	59.4	**50.7**	37.4	35.7	39.6	38.5	34.1	42.4	41.2	47.2	49.0	**40.6**
4	33.3	62.7	45.5	48.6	62.3	35.0	45.0	64.1	36.6	62.3	**51.3**	37.1	35.4	39.4	38.2	33.3	41.6	40.6	46.1	48.3	**40.0**
5	38.4	61.4	44.4	54.3	63.8	34.2	52.3	64.4	36.2	63.6	**52.7**	36.9	35.2	39.1	37.9	32.5	40.9	40.2	44.5	47.4	**39.4**
6	43.5	60.1	50.3	58.6	64.3	36.0	58.3	64.5	37.3	63.8	**54.8**	36.6	35.0	38.8	37.7	31.7	40.3	39.7	43.9	46.1	**38.9**
7	48.6	59.3	56.0	61.4	65.2	42.2	63.1	64.5	39.9	63.9	**57.3**	36.3	34.8	38.6	37.5	30.8	39.9	39.2	43.5	44.2	**38.3**
8	53.7	59.2	60.5	61.9	66.6	51.2	64.5	64.6	42.0	64.1	**59.4**	35.9	34.7	38.3	37.4	29.8	39.4	38.7	43.4	42.3	**37.8**
9	58.8	59.6	61.6	61.2	67.5	52.7	63.1	64.8	45.5	64.3	**60.0**	35.6	34.5	38.0	37.2	28.8	39.1	38.2	43.3	40.8	**37.3**
10	63.9	60.3	61.9	60.4	67.6	56.1	61.1	65.2	48.9	64.6	**60.7**	35.3	34.4	37.7	37.1	28.0	38.8	37.8	43.2	39.8	**36.9**
11	69.0	61.0	62.5	59.9	67.2	62.3	60.4	65.6	51.8	64.8	**61.7**	35.0	34.2	37.3	37.0	27.1	38.6	37.6	43.2	39.2	**36.6**
12	74.1	61.5	61.4	59.5	65.3	64.3	60.0	66.3	54.9	64.9	**62.0**	34.9	34.1	37.0	36.9	26.7	38.4	37.8	43.2	38.8	**36.4**
13	79.2	61.5	60.6	59.3	61.4	64.1	59.4	66.6	57.3	65.0	**61.7**	34.8	33.9	36.8	36.8	25.8	38.3	37.8	43.2	38.8	**36.2**
14	84.3	61.6	60.5	59.0	61.2	63.7	58.9	66.6	58.5	65.0	**61.7**	34.7	33.5	36.6	36.8	23.0	38.1	37.7	43.1	39.3	**35.9**
15	89.4	61.7	60.4	58.9	62.2	63.3	58.5	66.6	58.1	65.0	**61.6**	34.6	28.7	36.5	36.8	20.0	38.0	37.5	43.1	40.0	**35.0**
16	94.5	61.8	60.4	58.9	62.9	63.0	58.2	66.4	58.5	65.1	**61.7**	34.6	24.4	36.4	36.7	20.8	37.9	37.3	43.1	40.7	**34.6**
17	99.6	61.9	60.4	58.9	63.0	62.5	57.9	66.4	59.0	65.1	**61.7**	34.6	30.2	36.3	36.7	38.5	37.8	37.1	43.1	41.1	**37.3**
18	104.7	62.0	60.4	59.1	63.3	62.0	57.8	66.1	59.6	65.2	**61.7**	34.5	32.4	36.3	36.6	39.6	37.7	36.9	43.1	41.1	**37.6**
19	109.8	62.0	60.6	59.3	63.5	61.5	57.7	66.2	60.3	65.4	**61.8**	34.5	32.6	36.3	36.5	39.7	37.6	37.0	43.1	41.0	**37.6**
20	114.9	62.0	60.8	59.4	63.6	61.0	57.6	66.0	61.0	65.4	**61.9**	34.5	32.6	36.2	36.4	39.6	37.6	37.0	43.1	40.9	**37.5**
21	120.0	62.0	61.0	59.6	63.7	60.6	57.6	66.0	61.3	65.8	**62.0**	34.4	32.6	36.1	36.4	39.6	37.5	37.1	43.1	40.7	**37.5**
		58.4										**37.8**									

20.6

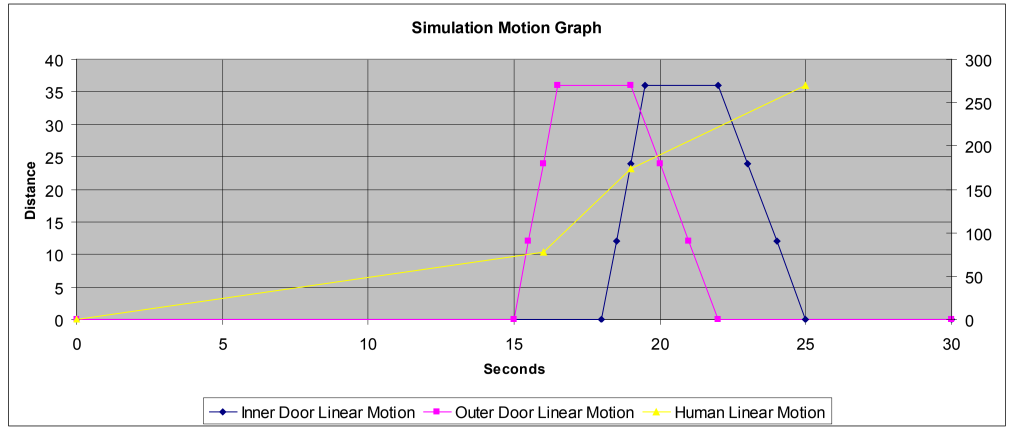


SIMULATION C1

(Vestibule w/ Air Door, Low Traffic, Low Wind, Winter)

	Description	Unit	Value
Boundary Condition	Interior Env. Endcap	psi	0
	Exterior Env. Endcap	psi	0
	Exterior Env. Endcap	Deg F	20
	Exterior Env. Endcap(Wind)	fpm	50
	Air Door Discharge (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	psi	0
	HVAC Fan Inlet (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	Deg F	110
Mesh	Building Walls, Diffuser	in	0
	Interior / Exterior Air Space, Endcaps	in	6
	Doorway Airspace, Door, HVAC Fan, Airdoor Cab, Human	in	3
	Airdoor Discharge	in	2
Materials	Building Walls	Brick Constant	
	All Air Volumes, Interior Airdoor Cabinet, HVAC Fan Area	Air Constant	
	Exterior Airdoor Cabinet, Human, Automatic Doors	Aluminum Constant	
Simulation Control	Analysis Mode	Transient	
	Time Step Size	0.05	
	Stop Time	30	
	Save Interval	See Table	
	Flow	Incompressible	
	Heat Transfer	On	
	Advection Scheme	ADV1	

Parameter	Unit	Value
Time Step Size	sec	0.05
Warm up Period	sec	15
Equalization Period	sec	2
Door Open Time	sec	1.5
Door Open Dwell Time	sec	2.5
Door Close Time	sec	3
Inner Door Lag Time	sec	3
Final Equalization Time	sec	5
Person Walking Speed(ft/min)	ft/min	
Non Door Cycle Result Freq	TS	3
Door Cycle Result Freq	TS	0.5



HVAC Fan Velocity	Time	fpm
1	0	4000
2	12	4000
3	13	0
4		
5		
6		
7		
8		
9		
10		

Air Door Discharge Velocity	Time	fpm
1	0	0
2	14.5	0
3	15	5000
4	24	5000
5	24.5	0
6		
7		
8		
9		
10		

Results Output Frequency	Time	Save Freq
1	0	3
2	15	0.5
3	25	3
4		
5		
6		
7		
8		
9		
10		

Start Operation TS	Stop Operation TS	Operation Description
0	300	**Interior Warm Up**
300	500	**Door Cycle**
500	600	**Equalization / Results**

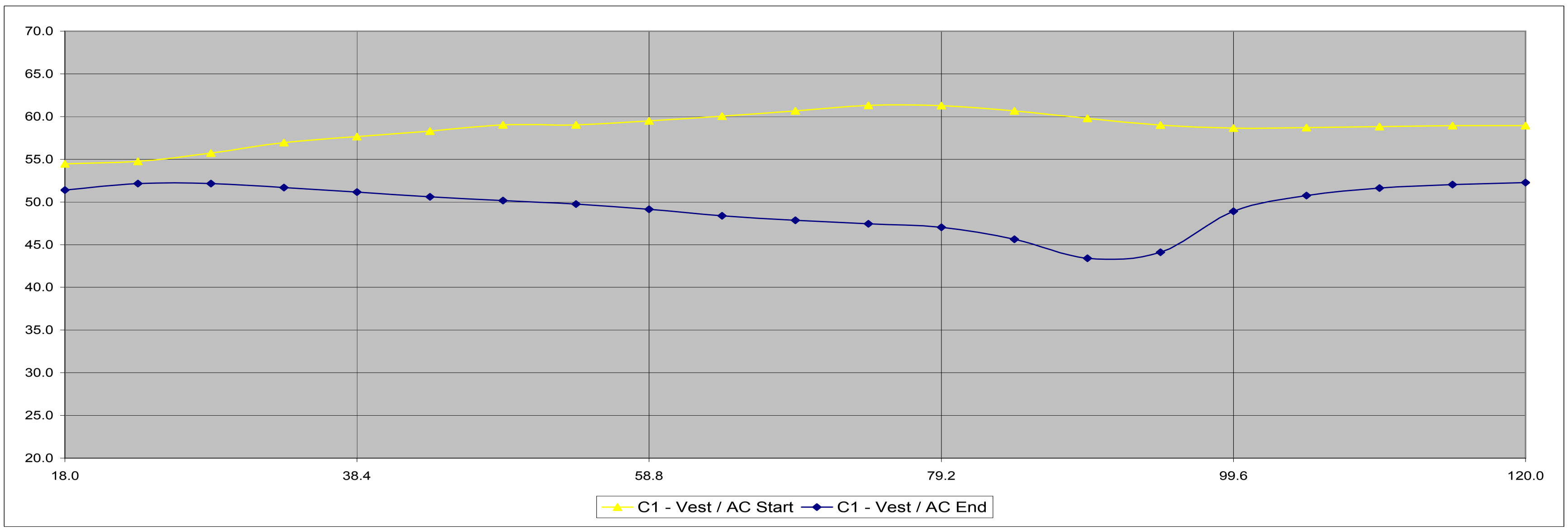
Outer Door Linear Motion	Distance	Time
1	0	0
2	0	15
3	12	15.5
4	24	16
5	36	16.5
6	36	19
7	24	20
8	12	21
9	0	22
10	0	30

Inner Door Linear Motion	Distance	Time
1	0	0
2	0	18
3	12	18.5
4	24	19
5	36	19.5
6	36	22
7	24	23
8	12	24
9	0	25
10	0	30

Human Linear Motion	Distance	Time
1	0	0
2	78	16
3	174	19
4	270	25
5		
6		
7		
8		
9		
10		

C1 Vest/AC LW, LT		C1 - Vest / AC Start										C1 - Vest / AC End									
Pt #	Pt Dist Fm Door	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg
		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90	
1	18.0	57.9	48.4	60.0	59.5	36.4	62.5	56.7	50.7	58.2	**54.5**	46.4	46.1	43.5	50.0	52.1	56.5	53.0	55.5	59.4	**51.4**
2	23.1	56.8	49.5	61.8	58.8	39.5	62.8	57.8	49.5	56.2	**54.8**	45.5	46.5	46.5	49.5	51.8	57.6	52.9	57.5	61.7	**52.2**
3	28.2	56.0	56.9	63.3	57.5	42.3	63.1	58.7	49.6	54.1	**55.7**	44.7	46.3	49.2	48.9	51.3	57.4	52.7	58.3	60.5	**52.1**
4	33.3	56.2	63.9	64.8	56.7	45.6	62.0	59.0	52.6	51.5	**56.9**	44.2	45.7	51.3	48.2	50.7	56.7	52.5	57.9	58.1	**51.7**
5	38.4	57.9	67.1	66.2	56.3	49.0	58.6	58.9	55.2	49.6	**57.6**	44.4	45.0	53.1	47.7	50.2	55.9	52.2	56.0	56.0	**51.2**
6	43.5	59.0	68.4	67.1	56.2	51.9	56.3	58.7	57.4	49.7	**58.3**	44.9	45.0	54.4	47.1	49.8	55.2	51.9	52.5	54.5	**50.6**
7	48.6	58.7	67.0	67.7	56.2	54.3	58.2	58.5	58.4	52.2	**59.0**	45.2	45.9	55.2	46.6	49.7	54.3	51.7	49.6	53.4	**50.2**
8	53.7	57.6	58.1	68.0	56.2	56.0	62.1	58.2	58.6	56.4	**59.0**	45.2	47.6	55.1	46.2	49.7	52.1	51.6	47.9	52.5	**49.8**
9	58.8	57.0	55.3	68.1	56.3	57.0	65.3	57.9	57.8	60.6	**59.5**	45.1	49.3	54.0	45.8	49.6	48.4	51.5	46.6	51.7	**49.1**
10	63.9	56.8	55.5	68.0	56.4	57.9	67.2	57.7	57.7	63.4	**60.1**	45.1	50.6	52.2	45.6	49.5	44.2	51.4	45.9	50.9	**48.4**
11	69.0	56.9	55.7	67.5	56.5	58.8	67.8	57.5	60.5	65.0	**60.7**	45.1	51.3	51.0	45.4	49.3	41.6	51.3	45.5	50.1	**47.9**
12	74.1	56.9	55.8	66.6	56.5	59.5	67.6	57.3	65.5	66.1	**61.3**	45.2	51.3	48.9	45.3	49.1	40.7	51.2	45.8	49.5	**47.5**
13	79.2	57.0	55.6	65.1	56.5	59.4	67.1	57.4	66.7	66.8	**61.3**	45.5	50.0	45.7	45.4	48.8	40.3	51.2	47.1	49.4	**47.0**
14	84.3	57.1	55.3	62.4	56.5	58.9	65.4	57.8	64.8	67.9	**60.7**	45.8	45.3	42.9	45.6	38.8	40.5	51.6	50.2	50.1	**45.6**
15	89.4	57.2	55.1	58.7	56.5	58.3	62.4	58.6	62.3	69.1	**59.8**	46.2	33.2	41.8	45.8	25.0	41.3	51.9	53.8	51.6	**43.4**
16	94.5	57.2	55.1	56.4	56.5	57.6	58.8	59.7	59.4	70.2	**59.0**	46.8	31.7	42.2	46.1	25.4	43.0	52.3	56.0	53.5	**44.1**
17	99.6	57.3	55.3	56.2	56.4	57.0	56.0	60.8	57.9	70.9	**58.6**	47.3	42.1	43.4	46.1	50.5	45.8	52.6	57.1	55.3	**48.9**
18	104.7	57.3	55.5	56.6	56.3	56.5	55.1	61.5	57.9	71.5	**58.7**	47.6	47.6	44.9	45.9	53.9	49.6	52.9	57.6	56.6	**50.7**
19	109.8	57.4	55.8	57.0	56.2	56.2	55.1	61.9	57.8	72.0	**58.8**	47.6	49.1	46.4	45.7	55.0	52.4	53.0	57.8	57.5	**51.6**
20	114.9	57.4	56.0	57.3	55.9	56.1	55.1	62.3	57.9	72.3	**58.9**	47.3	49.3	47.3	45.8	55.4	54.1	53.1	57.9	58.1	**52.0**
21	120.0	57.4	56.2	57.7	55.7	56.0	55.3	62.5	57.8	71.7	**58.9**	46.1	49.2	48.0	46.5	55.6	55.1	53.3	58.0	58.4	**52.3**

	C1 - Vest / AC Start	C1 - Vest / AC End
Average	**58.7**	**49.4**
Difference	**9.3**	

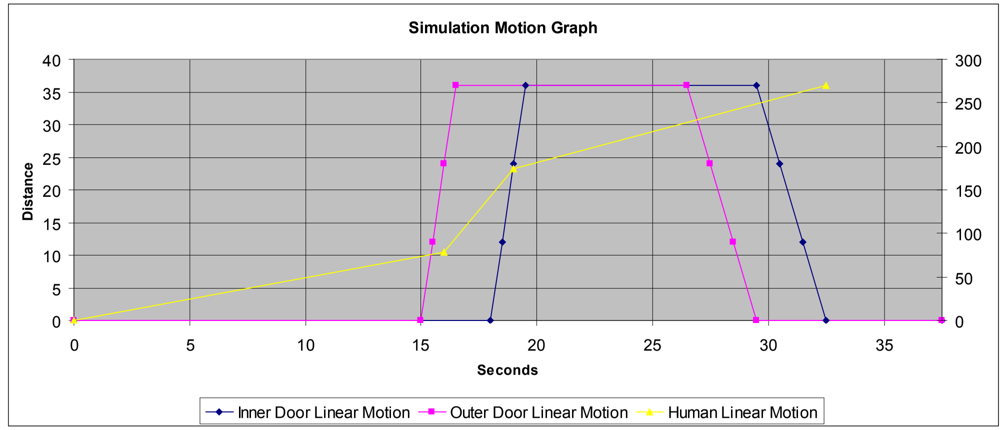


SIMULATION C2
(Vestibule w/ Air Door, High Traffic, Low Wind, Winter)

	Description	Unit	Value
Boundary Condition	Interior Env. Endcap	psi	0
	Exterior Env. Endcap	psi	0
	Exterior Env. Endcap	Deg F	20
	Exterior Env. Endcap(Wind)	fpm	50
	Air Door Discharge (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	psi	0
	HVAC Fan Inlet (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	Deg F	110
Mesh	Building Walls, Diffuser	in	0
	Interior / Exterior Air Space, Endcaps	in	6
	Doorway Airspace, Door, HVAC Fan, Airdoor Cab, Human	in	3
	Airdoor Discharge	in	2
Materials	Building Walls	Brick Constant	
	All Air Volumes, Interior Airdoor Cabinet, HVAC Fan Area	Air Constant	
	Exterior Airdoor Cabinet, Human, Automatic Doors	Aluminum Constant	
Simulation Control	Analysis Mode	Transient	
	Time Step Size	0.05	
	Stop Time	37.5	
	Save Interval	See Table	
	Flow	Incompressible	
	Heat Transfer	On	
	Advection Scheme	ADV1	

Parameter	Unit	Value
Time Step Size	sec	0.05
Warm up Period	sec	15
Equalization Period	sec	2
Door Open Time	sec	1.5
Door Open Dwell Time	sec	10
Door Close Time	sec	3
Inner Door Lag Time	sec	3
Final Equalization Time	sec	5
Person Walking Speed(ft/min)	ft/min	
Non Door Cycle Result Freq	TS	3
Door Cycle Result Freq	TS	0.5

Start Operation TS	Stop Operation TS	Operation Description
0	300	**Interior Warm Up**
300	650	**Door Cycle**
650	750	**Equalization / Results**



HVAC Fan Velocity	Time	fpm
1	0	4000
2	12	4000
3	13	0
4		
5		
6		
7		
8		
9		
10		

Air Door Discharge Velocity	Time	fpm
1	0	0
2	14.5	0
3	15	5000
4	31.5	5000
5	32	0
6		
7		
8		
9		
10		

Results Output Frequency	Time	Save Freq
1	0	3
2	15	0.5
3	32.5	3
4		
5		
6		
7		
8		
9		
10		

Outer Door Linear Motion	Distance	Time
1	0	0
2	0	15
3	12	15.5
4	24	16
5	36	16.5
6	36	26.5
7	24	27.5
8	12	28.5
9	0	29.5
10	0	37.5

Inner Door Linear Motion	Distance	Time
1	0	0
2	0	18
3	12	18.5
4	24	19
5	36	19.5
6	36	29.5
7	24	30.5
8	12	31.5
9	0	32.5
10	0	37.5

Human Linear Motion	Distance	Time
1	0	0
2	78	16
3	174	19
4	270	32.5
5		
6		
7		
8		
9		
10		

C2 Vest/AC LW, HT

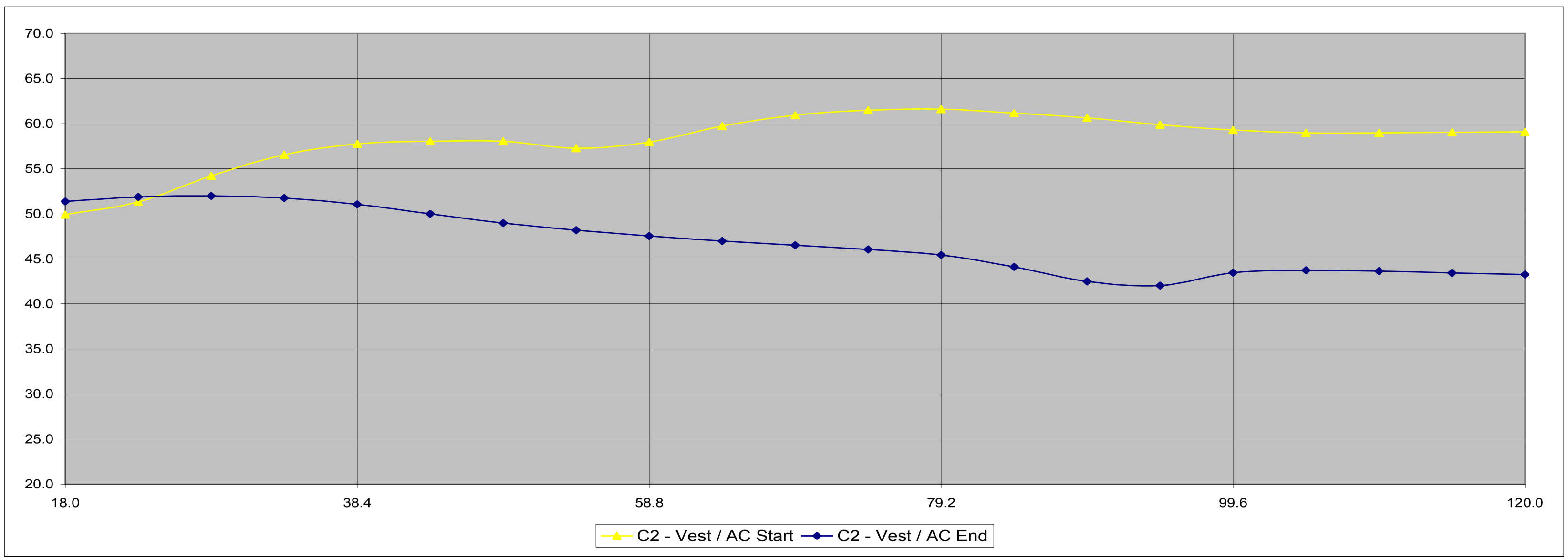
C2 - Vest / AC Start

Pt #	Pt Dist Fm Door	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg
		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90	
1	18.0	45.8	45.8	48.9	59.1	36.0	57.7	56.2	45.1	54.5	**49.9**
2	23.1	49.5	49.5	50.3	58.9	38.2	60.4	57.4	45.6	51.9	**51.3**
3	28.2	57.5	57.5	52.7	57.9	40.1	62.5	58.3	50.6	50.7	**54.2**
4	33.3	63.4	63.4	56.1	57.0	41.8	62.6	58.0	55.6	51.0	**56.6**
5	38.4	65.2	65.2	61.1	56.5	44.3	60.6	56.1	58.0	52.7	**57.7**
6	43.5	65.3	65.3	63.5	56.4	47.9	57.7	52.6	58.8	55.0	**58.0**
7	48.6	63.1	63.1	65.3	56.3	51.7	57.3	48.6	59.6	57.4	**58.0**
8	53.7	55.9	55.9	66.5	56.4	54.8	59.8	46.5	59.7	59.9	**57.3**
9	58.8	53.4	53.4	67.1	56.5	56.3	63.6	49.5	59.3	62.5	**58.0**
10	63.9	54.4	54.4	67.1	56.6	56.9	66.8	55.6	60.4	65.5	**59.7**
11	69.0	55.4	55.4	66.8	56.6	57.5	67.9	58.5	62.7	67.7	**60.9**
12	74.1	55.9	55.9	66.0	56.7	58.1	68.0	59.2	64.9	68.9	**61.5**
13	79.2	55.9	55.9	65.2	56.7	58.5	67.9	59.7	64.8	69.9	**61.6**
14	84.3	55.5	55.5	64.2	56.7	58.6	67.2	60.3	61.5	70.9	**61.2**
15	89.4	55.3	55.3	61.8	56.7	58.5	65.8	60.9	60.1	71.5	**60.6**
16	94.5	55.2	55.2	58.3	56.7	58.3	63.2	61.7	58.6	71.8	**59.9**
17	99.6	55.3	55.3	56.4	56.6	58.0	59.5	62.3	58.3	71.7	**59.3**
18	104.7	55.5	55.5	56.5	56.5	57.6	56.5	62.6	58.4	71.5	**59.0**
19	109.8	55.7	55.7	56.8	56.4	57.3	55.7	63.0	58.4	71.5	**59.0**
20	114.9	56.0	56.0	57.1	56.2	57.1	55.5	63.3	58.4	71.7	**59.0**
21	120.0	56.1	56.1	57.5	56.0	57.0	55.5	63.4	58.3	71.8	**59.1**
						58.2					

C2 - Vest / AC End

Pt #	Pt Dist Fm Door	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg
		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90	
1	18.0	47.6	41.6	51.6	48.4	50.1	55.0	51.7	57.3	58.9	**51.4**
2	23.1	47.4	44.3	53.6	47.9	50.0	55.8	51.6	57.7	58.4	**51.9**
3	28.2	47.1	46.7	54.5	47.5	49.6	56.0	51.6	57.2	57.5	**52.0**
4	33.3	46.9	48.7	54.6	47.2	49.1	55.7	51.5	55.0	56.9	**51.7**
5	38.4	46.6	50.1	53.1	47.0	48.6	53.9	51.5	51.9	56.5	**51.0**
6	43.5	46.3	50.6	49.8	46.9	48.1	50.8	51.5	49.6	56.2	**50.0**
7	48.6	46.1	50.3	46.5	46.8	47.4	47.9	51.4	48.4	56.0	**49.0**
8	53.7	45.9	49.1	44.9	46.7	46.6	45.7	51.3	47.7	55.7	**48.2**
9	58.8	45.9	47.5	44.4	46.6	45.5	44.2	51.2	47.1	55.2	**47.5**
10	63.9	46.0	46.0	44.4	46.6	44.3	43.2	51.1	46.5	54.6	**47.0**
11	69.0	46.2	44.7	44.6	46.6	43.0	42.6	51.1	45.9	53.7	**46.5**
12	74.1	46.3	43.8	44.9	46.6	41.3	42.1	51.1	45.4	52.7	**46.0**
13	79.2	46.4	42.7	45.3	46.6	38.3	41.8	51.0	45.1	51.7	**45.4**
14	84.3	46.6	39.9	45.8	46.6	30.6	41.5	50.8	44.7	50.5	**44.1**
15	89.4	46.6	32.6	46.3	46.4	25.0	41.3	50.5	44.4	49.4	**42.5**
16	94.5	46.7	30.5	46.0	46.1	25.2	41.2	50.0	44.1	48.4	**42.0**
17	99.6	46.8	37.8	44.4	45.4	34.5	41.1	49.6	43.9	47.6	**43.5**
18	104.7	46.8	41.5	42.6	44.6	37.1	41.0	49.4	43.6	47.0	**43.7**
19	109.8	46.9	42.6	41.7	43.4	38.1	40.9	49.0	43.5	46.6	**43.6**
20	114.9	46.9	42.6	41.3	42.3	38.4	40.9	48.8	43.3	46.4	**43.4**
21	120.0	46.9	42.2	41.1	41.4	38.5	40.9	48.6	43.3	46.4	**43.3**
						46.8					

11.3

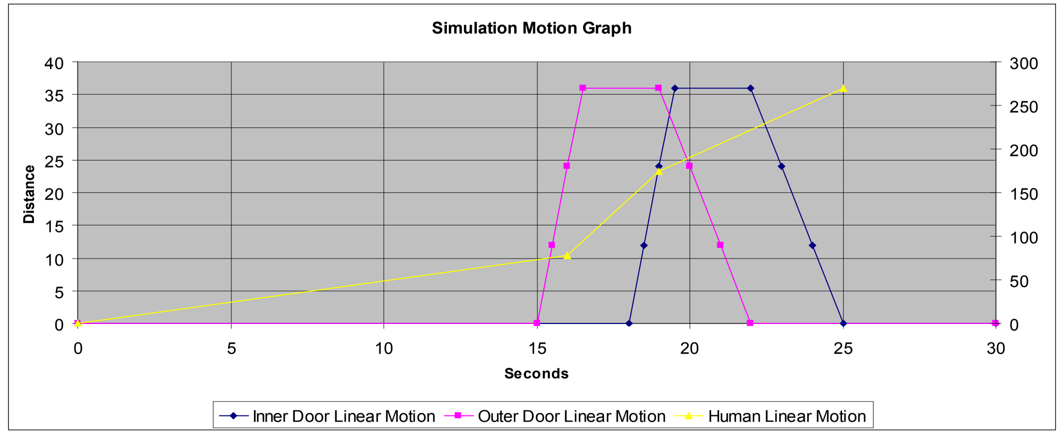


SIMULATION C3
(Vestibule w/ Air Door, Low Traffic, High Wind, Winter)

	Description	Unit	Value
Boundary Condition	Interior Env. Endcap	psi	0
	Exterior Env. Endcap	psi	0
	Exterior Env. Endcap	Deg F	20
	Exterior Env. Endcap(Wind)	fpm	352
	Air Door Discharge (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	psi	0
	HVAC Fan Inlet (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	Deg F	110
Mesh	Building Walls, Diffuser	in	0
	Interior / Exterior Air Space, Endcaps	in	6
	Doorway Airspace, Door, HVAC Fan, Airdoor Cab, Human	in	3
	Airdoor Discharge	in	2
Materials	Building Walls		Brick Constant
	All Air Volumes, Interior Airdoor Cabinet, HVAC Fan Area		Air Constant
	Exterior Airdoor Cabinet, Human, Automatic Doors		Aluminum Constant
Simulation Control	Analysis Mode		Transient
	Time Step Size		0.05
	Stop Time		30
	Save Interval		See Table
	Flow		Incompressible
	Heat Transfer		On
	Advection Scheme		ADV1

Parameter	Unit	Value
Time Step Size	sec	0.05
Warm up Period	sec	15
Equalization Period	sec	2
Door Open Time	sec	1.5
Door Open Dwell Time	sec	2.5
Door Close Time	sec	3
Inner Door Lag Time	sec	3
Final Equalization Time	sec	5
Person Walking Speed(ft/min)	ft/min	
Non Door Cycle Result Freq	TS	3
Door Cycle Result Freq	TS	0.5

Start Operation TS	Stop Operation TS	Operation Description
0	300	**Interior Warm Up**
300	500	**Door Cycle**
500	600	**Equalization / Results**



HVAC Fan Velocity	Time	fpm
1	0	4000
2	12	4000
3	13	0
4		
5		
6		
7		
8		
9		
10		

Air Door Discharge Velocity	Time	fpm
1	0	0
2	14.5	0
3	15	5000
4	24	5000
5	24.5	0
6		
7		
8		
9		
10		

Results Output Frequency	Time	Save Freq
1	0	3
2	15	0.5
3	25	3
4		
5		
6		
7		
8		
9		
10		

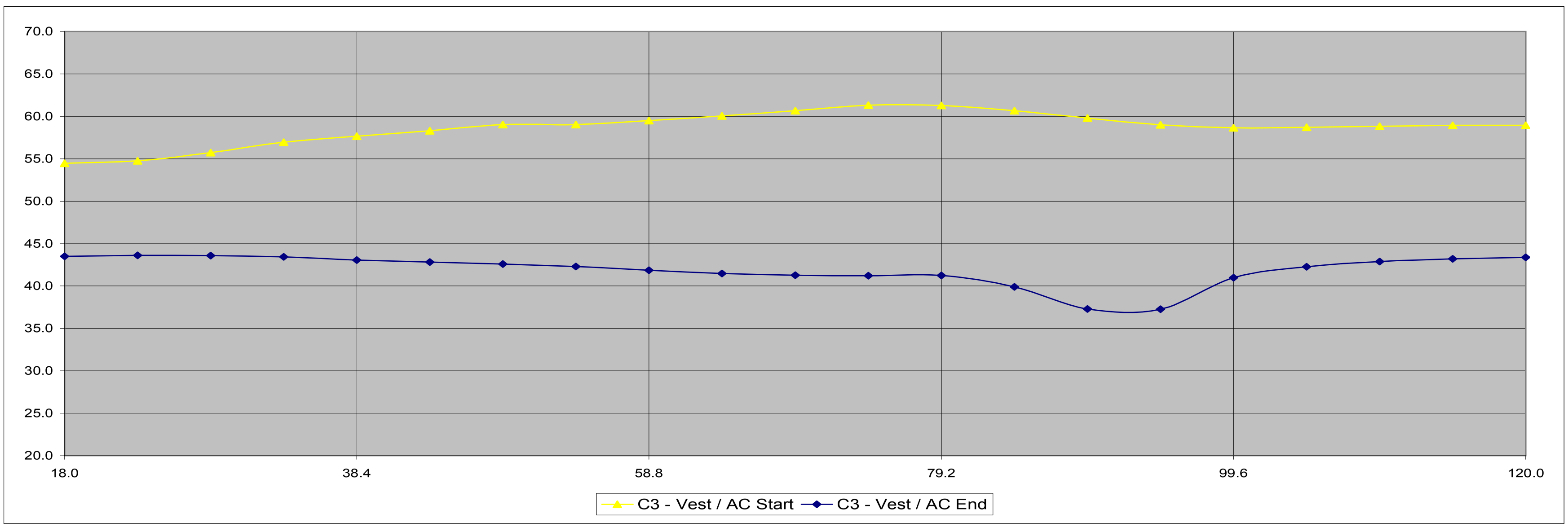
Outer Door Linear Motion	Distance	Time
1	0	0
2	0	15
3	12	15.5
4	24	16
5	36	16.5
6	36	19
7	24	20
8	12	21
9	0	22
10	0	30

Inner Door Linear Motion	Distance	Time
1	0	0
2	0	18
3	12	18.5
4	24	19
5	36	19.5
6	36	22
7	24	23
8	12	24
9	0	25
10	0	30

Human Linear Motion	Distance	Time
1	0	0
2	78	16
3	174	19
4	270	25
5		
6		
7		
8		
9		
10		

C3 Vest/AC HW, LT		C3 - Vest / AC Start										C3 - Vest / AC End									
Pt #	Pt Dist Fm Door	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg
		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90	
1	18.0	57.9	48.4	60.0	59.5	36.4	62.5	56.7	50.7	58.2	**54.5**	40.0	37.7	38.2	40.4	42.3	50.3	43.1	47.6	51.8	**43.5**
2	23.1	56.8	49.5	61.8	58.8	39.5	62.8	57.8	49.5	56.2	**54.8**	39.9	39.0	41.0	39.9	42.5	50.4	42.7	48.2	49.0	**43.6**
3	28.2	56.0	56.9	63.3	57.5	42.3	63.1	58.7	49.6	54.1	**55.7**	39.8	39.7	43.0	39.5	42.7	49.8	42.1	48.7	46.9	**43.6**
4	33.3	56.2	63.9	64.8	56.7	45.6	62.0	59.0	52.6	51.5	**56.9**	39.8	40.2	44.2	39.2	42.9	49.4	41.6	47.7	45.8	**43.4**
5	38.4	57.9	67.1	66.2	56.3	49.0	58.6	58.9	55.2	49.6	**57.6**	39.7	40.5	45.1	39.0	43.2	49.1	41.1	44.7	45.2	**43.1**
6	43.5	59.0	68.4	67.1	56.2	51.9	56.3	58.7	57.4	49.7	**58.3**	39.8	40.6	45.6	38.9	43.4	49.0	40.8	42.5	44.8	**42.8**
7	48.6	58.7	67.0	67.7	56.2	54.3	58.2	58.5	58.4	52.2	**59.0**	40.0	40.5	45.7	38.8	43.5	48.4	40.7	41.1	44.4	**42.6**
8	53.7	57.6	58.1	68.0	56.2	56.0	62.1	58.2	58.6	56.4	**59.0**	40.0	40.3	45.5	38.8	43.7	47.0	40.6	40.6	44.0	**42.3**
9	58.8	57.0	55.3	68.1	56.3	57.0	65.3	57.9	57.8	60.6	**59.5**	39.7	40.4	44.8	38.8	43.7	44.5	40.7	40.5	43.6	**41.9**
10	63.9	56.8	55.5	68.0	56.4	57.9	67.2	57.7	57.7	63.4	**60.1**	39.4	41.1	43.6	38.9	43.7	41.8	40.8	40.6	43.3	**41.5**
11	69.0	56.9	55.7	67.5	56.5	58.8	67.8	57.5	60.5	65.0	**60.7**	39.3	42.1	42.2	39.0	43.7	40.0	41.0	40.9	43.1	**41.3**
12	74.1	56.9	55.8	66.6	56.5	59.5	67.6	57.3	65.5	66.1	**61.3**	39.3	43.0	40.3	39.0	43.9	39.0	41.3	41.9	43.2	**41.2**
13	79.2	57.0	55.6	65.1	56.5	59.4	67.1	57.4	66.7	66.8	**61.3**	39.2	43.1	38.5	39.1	44.2	38.6	41.6	43.3	43.7	**41.2**
14	84.3	57.1	55.3	62.4	56.5	58.9	65.4	57.8	64.8	67.9	**60.7**	39.0	40.1	37.1	39.0	33.4	38.6	41.8	45.0	44.9	**39.9**
15	89.4	57.2	55.1	58.7	56.5	58.3	62.4	58.6	62.3	69.1	**59.8**	38.9	28.1	36.4	38.9	20.0	38.8	42.0	46.0	46.4	**37.3**
16	94.5	57.2	55.1	56.4	56.5	57.6	58.8	59.7	59.4	70.2	**59.0**	39.0	24.8	36.3	39.0	20.3	39.3	42.1	46.8	47.9	**37.3**
17	99.6	57.3	55.3	56.2	56.4	57.0	56.0	60.8	57.9	70.9	**58.6**	39.1	33.5	36.7	39.4	41.2	40.6	42.1	47.2	49.0	**41.0**
18	104.7	57.3	55.5	56.6	56.3	56.5	55.1	61.5	57.9	71.5	**58.7**	39.1	37.8	37.5	39.8	44.0	42.7	42.2	47.5	49.8	**42.3**
19	109.8	57.4	55.8	57.0	56.2	56.2	55.1	61.9	57.8	72.0	**58.8**	38.7	39.3	38.5	40.2	44.7	44.4	42.2	47.6	50.4	**42.9**
20	114.9	57.4	56.0	57.3	55.9	56.1	55.1	62.3	57.9	72.3	**58.9**	38.1	39.7	39.3	40.5	44.9	45.5	42.2	47.8	50.8	**43.2**
21	120.0	57.4	56.2	57.7	55.7	56.0	55.3	62.5	57.8	71.7	**58.9**	37.5	39.8	39.9	40.7	44.9	46.4	42.4	47.9	50.9	**43.4**
		58.7										**41.9**									

16.8

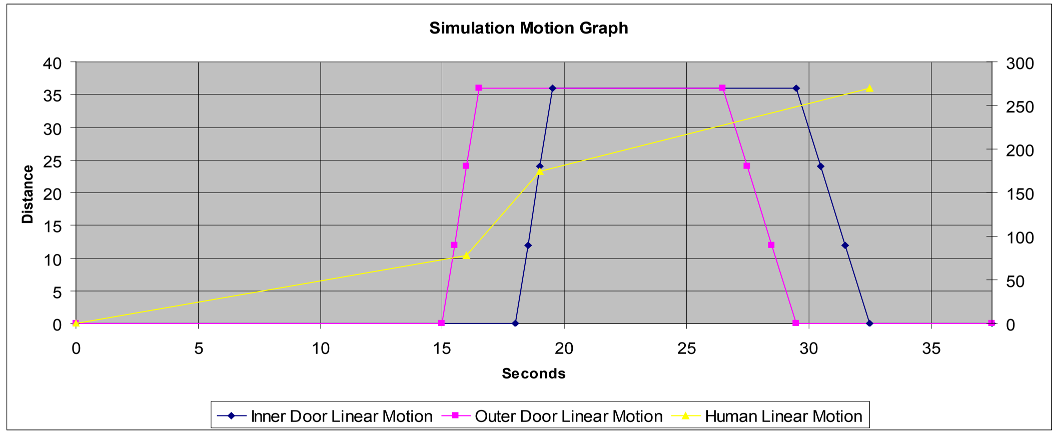


SIMULATION C4

(Vestibule w/ Air Door, High Traffic, High Wind, Winter)

	Description	Unit	Value
Boundary Condition	Interior Env. Endcap	psi	0
	Exterior Env. Endcap	psi	0
	Exterior Env. Endcap	Deg F	20
	Exterior Env. Endcap(Wind)	fpm	352
	Air Door Discharge (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	psi	0
	HVAC Fan Inlet (Transient Piecewise Linear)	fpm	See Table
	HVAC Fan Inlet	Deg F	110
Mesh	Building Walls, Diffuser	in	0
	Interior / Exterior Air Space, Endcaps	in	6
	Doorway Airspace, Door, HVAC Fan, Airdoor Cab, Human	in	3
	Airdoor Discharge	in	2
Materials	Building Walls	Brick Constant	
	All Air Volumes, Interior Airdoor Cabinet, HVAC Fan Area	Air Constant	
	Exterior Airdoor Cabinet, Human, Automatic Doors	Aluminum Constant	
Simulation Control	Analysis Mode	Transient	
	Time Step Size	0.05	
	Stop Time	37.5	
	Save Interval	See Table	
	Flow	Incompressible	
	Heat Transfer	On	
	Advection Scheme	ADV1	

Parameter	Unit	Value
Time Step Size	sec	0.05
Warm up Period	sec	15
Equalization Period	sec	2
Door Open Time	sec	1.5
Door Open Dwell Time	sec	10
Door Close Time	sec	3
Inner Door Lag Time	sec	3
Final Equalization Time	sec	5
Person Walking Speed(ft/min)	ft/min	
Non Door Cycle Result Freq	TS	3
Door Cycle Result Freq	TS	0.5



Start Operation TS	Stop Operation TS	Operation Description
0	300	**Interior Warm Up**
300	650	**Door Cycle**
650	750	**Equalization / Results**

HVAC Fan Velocity	Time	fpm
1	0	4000
2	12	4000
3	13	0
4		
5		
6		
7		
8		
9		
10		

Air Door Discharge Velocity	Time	fpm
1	0	0
2	14.5	0
3	15	5000
4	31.5	5000
5	32	0
6		
7		
8		
9		
10		

Results Output Frequency	Time	Save Freq
1	0	3
2	15	0.5
3	32.5	3
4		
5		
6		
7		
8		
9		
10		

Outer Door Linear Motion	Distance	Time
1	0	0
2	0	15
3	12	15.5
4	24	16
5	36	16.5
6	36	26.5
7	24	27.5
8	12	28.5
9	0	29.5
10	0	37.5

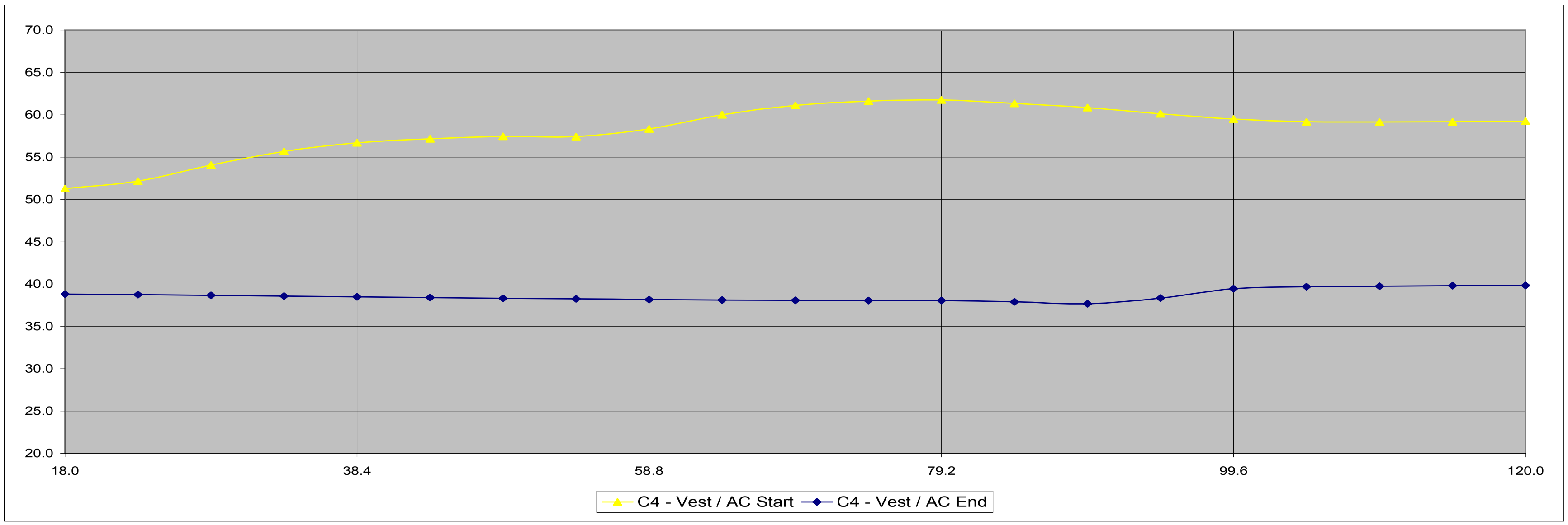
Inner Door Linear Motion	Distance	Time
1	0	0
2	0	18
3	12	18.5
4	24	19
5	36	19.5
6	36	29.5
7	24	30.5
8	12	31.5
9	0	32.5
10	0	37.5

Human Linear Motion	Distance	Time
1	0	0
2	78	16
3	174	19
4	270	32.5
5		
6		
7		
8		
9		
10		

C4 Vest/AC HW, HT

Pt #	Pt Dist Fm Door	C4 - Vest / AC Start										C4 - Vest / AC End									
		LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg	LEFT (40,X,18 to 40,X,120)			CENTER (0,X,18 to 0,X,120)			RIGHT (-40,X,18 to -40,X,120)			Avg
		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90		X=18	X=54	X=90	X=18	X=54	X=90	X=18	X=54	X=90	
1	18.0	58.1	45.8	48.9	59.1	36.0	57.7	56.2	45.1	54.5	**51.3**	40.5	39.9	38.8	39.8	39.1	38.4	40.5	37.5	34.7	**38.8**
2	23.1	57.3	49.5	50.3	58.9	38.2	60.4	57.4	45.6	51.9	**52.2**	40.1	39.4	38.3	39.8	38.8	38.7	40.6	38.2	35.0	**38.8**
3	28.2	56.1	57.5	52.7	57.9	40.1	62.5	58.3	50.6	50.7	**54.0**	39.9	38.6	38.2	39.7	38.5	38.7	40.6	38.5	35.3	**38.7**
4	33.3	55.3	63.4	56.1	57.0	41.8	62.6	58.0	55.6	51.0	**55.7**	39.8	37.7	38.2	39.7	38.2	38.7	40.7	38.6	35.6	**38.6**
5	38.4	55.8	65.2	61.1	56.5	44.3	60.6	56.1	58.0	52.7	**56.7**	39.7	36.9	38.3	39.7	37.8	38.7	40.7	38.6	35.9	**38.5**
6	43.5	57.2	65.3	63.5	56.4	47.9	57.7	52.6	58.8	55.0	**57.1**	39.7	36.2	38.3	39.7	37.5	38.7	40.8	38.7	36.2	**38.4**
7	48.6	57.8	63.1	65.3	56.3	51.7	57.3	48.6	59.6	57.4	**57.5**	39.6	35.6	38.4	39.7	37.1	38.6	40.8	38.8	36.4	**38.3**
8	53.7	57.3	55.9	66.5	56.4	54.8	59.8	46.5	59.7	59.9	**57.4**	39.6	35.0	38.4	39.7	36.6	38.6	40.8	38.9	36.6	**38.2**
9	58.8	56.9	53.4	67.1	56.5	56.3	63.6	49.5	59.3	62.5	**58.3**	39.6	34.6	38.5	39.7	36.1	38.6	40.8	39.0	36.7	**38.2**
10	63.9	56.8	54.4	67.1	56.6	56.9	66.8	55.6	60.4	65.5	**60.0**	39.5	34.2	38.6	39.7	35.8	38.5	40.8	39.1	36.9	**38.1**
11	69.0	56.8	55.4	66.8	56.6	57.5	67.9	58.5	62.7	67.7	**61.1**	39.5	33.9	38.6	39.8	35.4	38.5	40.8	39.2	37.1	**38.1**
12	74.1	56.9	55.9	66.0	56.7	58.1	68.0	59.2	64.9	68.9	**61.6**	39.5	33.5	38.7	39.8	35.0	38.4	40.7	39.7	37.2	**38.1**
13	79.2	57.0	55.9	65.2	56.7	58.5	67.9	59.7	64.8	69.9	**61.7**	39.5	33.3	38.7	39.8	33.8	38.4	40.7	40.7	37.3	**38.0**
14	84.3	57.1	55.5	64.2	56.7	58.6	67.2	60.3	61.5	70.9	**61.3**	39.5	32.7	38.8	39.8	31.0	38.4	40.7	42.9	37.5	**37.9**
15	89.4	57.2	55.3	61.8	56.7	58.5	65.8	60.9	60.1	71.5	**60.9**	39.5	32.1	38.8	39.8	29.0	38.3	40.7	43.2	37.6	**37.7**
16	94.5	57.2	55.2	58.3	56.7	58.3	63.2	61.7	58.6	71.8	**60.1**	39.5	37.5	38.9	39.8	29.1	38.3	40.7	43.5	37.7	**38.4**
17	99.6	57.3	55.3	56.4	56.6	58.0	59.5	62.3	58.3	71.7	**59.5**	39.5	39.6	39.0	39.9	36.8	38.3	40.7	43.6	37.9	**39.5**
18	104.7	57.3	55.5	56.5	56.5	57.6	56.5	62.6	58.4	71.5	**59.2**	39.5	39.7	39.0	39.9	38.4	38.3	40.8	43.5	38.0	**39.7**
19	109.8	57.3	55.7	56.8	56.4	57.3	55.7	63.0	58.4	71.5	**59.2**	39.5	39.7	39.1	39.9	38.8	38.4	40.8	43.4	38.2	**39.7**
20	114.9	57.4	56.0	57.1	56.2	57.1	55.5	63.3	58.4	71.7	**59.2**	39.4	39.7	39.2	39.9	39.0	38.4	40.9	43.3	38.4	**39.8**
21	120.0	57.4	56.1	57.5	56.0	57.0	55.5	63.4	58.3	71.8	**59.2**	39.4	39.7	39.3	39.9	39.0	38.4	41.0	43.2	38.7	**39.8**
		58.2										**38.6**									

19.6



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February 1, 2008

Berner International
Air Door Simulation Comparison

Analysis by: Apolo Vanderberg
Project Engineer, Engineering Services

Reviewed by: Jason Pfeiffer
Director, Engineering Services

Project Summary:

A computational fluid dynamics analysis was performed on a Berner International Air Door to compare results to a typical Vestibule setup. Blue Ridge Numerics, Inc. was asked to confirm that the models were run as accurately as possible. Berner International wanted to verify that an Air Door could perform as well as a Vestibule, or better under certain loading conditions. With this information Berner International will submit a white paper to IECC to help change a code that requires Vestibules for buildings. For both models, the loading condition used for the simulation was a worst case scenario of winter with high traffic, and high wind. This transient simulation, including motion of the doors and a person walking through the domain, was conducted using CFdesign version 9.0 from Blue Ridge Numerics, Inc.

For each analysis, all setup conditions for the wind loading, temperature and the timing of the events for the motion of the solids were given by Berner International. Blue Ridge Numerics, Inc was asked to compare the results of each model given the setup parameters and to ensure a high fidelity simulation and results.

Simulation Enhancements:

To ensure that the process and physics were properly captured by the analysis, some minor enhancements were done to the simulation. The meshing was refined to better capture temperature and velocity gradients in areas of high importance. The Boundary Conditions for the inlet overly constrained the flow, so removing this constraint allowed the high wind to develop correctly and act as the worst case scenario for the comparison between the Vestibule and Air Door. The final item altered was the Time Step Size. A smaller value was used to ensure that the motion of the doors, person and sequence of events were captured accurately and that the flow around these object would develop in a stable fashion.

Conclusion:

Results from the simulations show that for the given loadings an Air Door can perform as well, if not better than a Vestibule in high traffic conditions. To compare the two models bulk temperatures were taken on cut surfaces within the interior domain. These bulk temperatures were taken across the interior domain roughly six (6) inches from the ceiling and roughly seven (7) inches from the floor. With these data points the Air Door maintains about 30% warmer temperatures near the ceiling, and roughly 40% warmer temperatures at the floor. The high traffic scenario requires that the Vestibule doors overlap with their open dwell time which allows a significant amount of heat loss. Figure 1 shows the temperature difference between the Air Door (Left) and the Vestibule (Right) during the simulation.

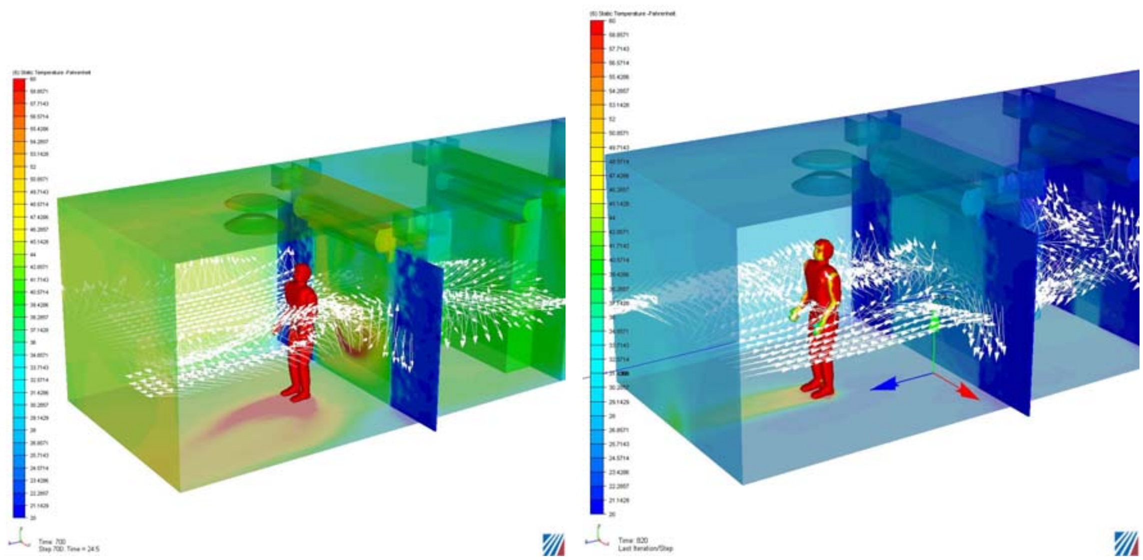

Figure 1. Velocity vectors and temperature contours for Air Door (left) and Vestibule (right)

cfdesign® Upfront CFD

blue ridge numerics

Appendix D - Energy Savings Calculation

Heat Check

Customer Input

Enter data only in **Red** area

Description	Variable	Customer Information	Units
Temperature Inside	Ti	68	F
Temperature Outside	To	20	F
Opening (door) Height	H	7	ft
Opening (door) Width	W	6	ft
Wind Speed	Vw	4	mph
Door Open Time	td	20	hrs/week
Season Heating Time	tw	17	weeks
Cost of Heat	Hc	9	$/mbtu
Cost of Electricity	Ec	0.12	$/kwh
Air Curtain HP	Hp	1	hp
Cost of Air Curtain	Ac	1800	$
Cost of AC Installation	Ai	200	$

Results

Description	Variable	?	Units
Temperature Differential	Tdt	48	
Air Density Inside	Ri	0.075225	LBM/FT^3
Air Density Outside	Ro	0.082748	LBM/FT^3
Air Flow Rate Temp	Qt	2298.647	CFM
Heat Loss Temperature	Ht	126018.6	BTU/HR
Air Flow Wind	Qw	7392	CFM
Heat Loss Wind	Hw	405251.2	BTU/HR
Heat Loss Total	Htl	403159.2	BTU/HR
Heat Loss/Season	Hs	137.0741	MBTU/HR
Heat Saved by AC	Hr	95.95189	MBTU/HR
Cost of Heat Loss no AC	Hn	1233.667	$/MBTU
Cost of Heat Saved w/AC	Hac	863.567	$/MBTU
Cost to Run AC	Eac	30.4368	$
Payback w/o Run Cost	P	2.3160	Yrs

Heat Application Equation used for Energy Calculation

Breeze Code Outline: Heat

10Aug2001
Rev. 06Aug2002

Author: David A. Johnson

Customer Input:	Variable	Units
Temperature Inside:	Ti	Degrees F
Temperature Outside:	To	Degrees F
Opening (door) Height:	H	Feet
Opening (door) Width:	W	Feet
Wind Speed:	Vw	MPH
Door Open Time:	td	Hrs/Week
Season Heating Time:	tw	Weeks
Cost of Heat:	Hc	$/MBTU
Cost of Electricity:	Ec	$/KWH
Air Curtain HP:	Hp	HP
Cost of Air Curtain:	Ac	$
Cost of AC Installation:	Ai	$

Calculate:	Variable/Equation	Units
Temperature Differential:	Tdt=Ti-To	
Air Density Inside:	Ri=(14.696/(0.37*(460+Ti)))	LBM/FT^3
Air Density Outside:	Ro=(14.696/(0.37*(460+To)))	LBM/FT^3
Air Flow Rate Temp:	Qt	CFM

Qt=(0.48+0.0023*Tdt)*(40*H*W)*(((64.4*H*(1Ri/Ro))/((1+((Ri/Ro)^(1/3)))^3))^0.5)

Heat Loss Temp:	Ht=(Qt*((Ri+Ro)/2)*0.241*Tdt)*60	BTU/HR
Air Flow Rate Wind:	Qw=(0.5*H*W*Vw*88)	CFM
Heat Loss Wind:	Hw=(Qw*((Ri+Ro)/2)*0.241*Tdt)*60	BTU/HR
Heat Loss Total:	Htl=(Qt^2+Qw^2)^0.5*1.085*Tdt	BTU/HR
Heat Loss/Season:	Hs=(Htl*td*Tw)/1000000	MBTU/HR
Heat Saved by AC:	Hr=0.7*Hs	MBTU/HR
Cost of Heat Lost no AC:	Hn=Hs*Hc	$/MBTU
Cost of Heat Lost w/AC:	Hac=0.7*Hn	$/MBTU
Cost to Run AC:	Eac=(Hp*Ec*0.746*td*Tw)	$
Payback:	P=(Ac+Ai)/Hac	Yrs

Other Equations - Cool Application

Breeze Code Outline: Cool
14Aug2001
Author: David A. Johnson

Customer Input:	Variable	Units
Temperature Inside:	Ti	Degrees F
Relative Humidity Inside:	RHi	%
Temperature Outside:	To	Degrees F
Relative Humidity Inside:	RHo	%
Opening (door) Height:	H	Feet
Opening (door) Width:	W	Feet
Wind Speed:	Vw	MPH
Door Open Time:	td	Hrs/Week
Cooling Season Time:tw		Weeks
Cost of Electricity:	Ec	$/KWH
Air Curtain HP:	Hp	HP
Cost of Air Curtain:	Ac	$
Cost of AC Installation:	Ai	$

Calculate:	Variable/Equation	Units
Absolute Indoor Temp:	Tai=Ti+460	Degrees R
Absolute Outdoor Temp:	Tao=To+460	Degrees R
Natural Log PWS Indoor:	Pwi	
Pwi=(10440.4/Tai)+(11.295)+(0.027*Tai)+(1.2898E05*(Tai^2))+(2.478E09*(Tai^3))+(6.546*LN(Tai))		
Natural Log PWS Outdoor:	Pwo	
Pwo=(10440.4/Tao)+(11.295)+(0.027*Tao)+(1.2898E05*(Tao^2))+(2.478E09*(Tao^3))+(6.546*LN(Tao))		
Indoor PWS:	Pi=exp(Pwi)	
Outdoor PWS:	Po=exp(Pwo)	
Humidity Ratio Indoor:	HRi=(0.62198)*(RHi/100*Pi)/(14.696(RHi/100*Pi))	
Humidity Ratio Outdoor:	HRo=(0.62198)*(RHo/100*Po)/(14.696(RHo/100*Po))	
Indoor Specific Volume:	Vsi=(0.37*Tai)/(14.696(RHi/100)*Pi)	ft^3/lbm
Outdoor Specific Volume:	Vso=(0.37*Tao)/(14.696(RHo/100)*Po)	ft^3/lbm
Indoor Air Density:	Ri=(1/Vsi)*(1+HRi)	lbm/ft^3
Outdoor Air Density:	Ro=(1/Vso)*(1+HRo)	lbm/ft^3
Airflow Rate:	Q	CF
Q=(0.48+0.0023*(ToTi))*(40*H*W)*(((64.4*H*(1Ro/Ri))/((1+((Ro/Ri)^(1/3)))^3))^0.5)		
Sensible Heat:	SH=(1.085*Q*(ToTi))	BTU/HR
Latent Heat:	Hl=(4840*Q*(HRoHRi))	BTU/HR
Subtotal Heat Gain:	HGs=Hl+SH	BTU/HR
Air Flow Rate Wind:	Qw=(0.5*H*W*Vw*88)	CFM
Heat Gain:	HG=(1.085*(ToTi)+4840*(HRoHRi))*Qw	BTU/HR
Heat Gain Total:	HGt=((HGs^2+HG^2)^0.5)	BTU/HR
Cost Heat Gain:	Hgc=(HGt/12000*td*tw*Ec)	$/Season
Savings by AC:	Er=0.7*Hgc	$/Season
Cost to Run AC:	Eac=(Hp*Ec*0.746*td*tw)	$
Payback:	P=(Ac+Ai)/(Er-Eac)	Yrs

Other Equations - Freezer Application

Breeze Code Outline: Freeze 19Aug2001

Author: David A. Johnson

Customer Input:	Variable	Units
Temperature Inside:	Ti	Degrees F
Relative Humidity Inside:	RHi	%
Temperature Outside:	To	Degrees F
Relative Humidity Inside:	RHo	%
Opening (door) Height:	H	Feet
Opening (door) Width:	W	Feet
Wind Speed:	Vw	MPH
Door Open Time:	td	Hrs/Week
Cooling Season Time:tw		Weeks
Cost of Electricity:	Ec	$/KWH
Air Curtain HP:	Hp	HP
Cost of Air Curtain:	Ac	$
Cost of AC Installation:	Ai	$

Calculate:	Variable/Equation	Units
Absolute Indoor Temp:	Tai=Ti+460	Degrees R
Absolute Outdoor Temp:	Tao=To+460	Degrees R

Indoor F: Fi=(10214.16/Tai)+(4.8932631)+(0.0053769056*Tai)+(1.9202377E07*(Tai^2))

Outdoor F: Fo=(10440.4/Tao)+(11.2946669)+(0.02700133*Tao)+(1.28971E05*(Tao^2))

Natural Log PWS Indoor:

Pwi=(Fi)+(0.35575832/1000000000*(Tai^3))+(9.0344688E14*(Tai^4))+(4.1635019*(LN(Tai)))

Natural Log PWS Outdoor:	Pwo=(Fo)+(2.478068E09*(Tao^3))+(6.5459673*LN(Tao))	
Indoor PWS:	Pi=exp(Pwi)	
Outdoor PWS:	Po=exp(Pwo)	
Humidity Ratio Indoor:	HRi=(0.62198)*(RHi/100*Pi)/(14.696(RHi/100*Pi))	
Humidity Ratio Outdoor:	HRo=(0.62198)*(RHo/100*Po)/(14.696(RHo/100*Po))	
Indoor Specific Volume:	Vsi=(0.37*Tai)/(14.696(RHi/100)*Pi)	ft^3/lbm
Outdoor Specific Volume:	Vso=(0.37*Tao)/(14.696(RHo/100)*Po)	ft^3/lbm
Indoor Air Density:	Ri=(1/Vsi)*(1+HRi)	lbm/ft^3
Outdoor Air Density:	Ro=(1/Vso)*(1+HRo)	lbm/ft^3
Airflow Rate:	Q	CFM

Q=(0.48+0.0023*(ToTi))*(40*H*W)*(((64.4*H*(1Ro/Ri))/((1+((Ro/Ri)^(1/3)))^3))^0.5)

Sensible Heat:	SH=(1.085*Q*(ToTi))	BTU/HR
Latent Heat:	Hl=(4840*Q*(HRoHRi))	BTU/HR
Subtotal Heat Gain:	HGs=Hl+SH	BTU/HR
Air Flow Rate Wind:	Qw=(0.5*H*W*Vw*88)	CFM
Heat Gain:	HG=(1.085*(ToTi)+4840*(HRoHRi))*Qw	BTU/HR
Heat Gain Total:	HGt=((HGs^2+HG^2)^0.5)	BTU/HR
Cost Heat Gain:	HGc=(HGt/12000*td*tw*Ec)	$/Season
Savings by AC:	Er=0.7*Hgc	$/Season
Cost to Run AC:	Eac=(Hp*Ec*0.746*td*tw)	$
Payback:	P=(Ac+Ai)/(Er-Eac)	Yrs

Appendix E - Bibliography of Previous Research

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Appendix F - Author Biographies

David Johnson

David Johnson, Engineering Manager, has spent 19 years in the engineering field and has been with Berner International Corp. for over 18 years. He has worked to acquire a number of patents in his career including those for an Air Curtain digital controller, a specialty application Air Curtain and Air Curtain nozzle design. A member of the Air Movement and Control Association (AMCA), Johnson serves as chair on the AMCA Air Movement Engineering Standards Committee and Air Curtain Engineering Standards Committee and is Vice Chair for the AMCA Air Movement Division. He has authored articles for the ASHRAE Journal and Air Curtain application manuals and has participated in a USDA research study on Air Curtains.

Philip Thomas

Philip Thomas, Project Engineer, has been developing new products for over 14 years in a variety of markets including Automotive, Consumer and HVAC. He holds patents covering Ball Valve Seals and Fire Protection Devices. He also has a patent pending on Air Curtain Nozzle Design. His research utilizing Computational Fluid Dynamics software to analyze environmental separation was featured in Machine Design magazine.

Leah Kordecki

Research Assistant & Editor

Appendix G - Company Biography

Berner International Corp. has established itself as the leading manufacturer of air curtains/air doors and related products for over 50 years. All Berner air doors are built with pride in New Castle, Pennsylvania. Our mission is to help our customers save energy and create healthy, comfortable environments.

Our air doors support this mission by employing a controlled stream of air, aimed across an opening, to create an air seal. This seal separates different environments, while allowing a smooth, unhindered flow of traffic and an unobstructed view through the opening. Because our air doors effectively contain heated or air conditioned air, they can provide sizeable energy savings and personal comfort when applied in industrial, commercial, and food service settings.

Berner catalogues over 406 different configurations of air doors. To ensure our units perform as stated, each air door is built by Berner technicians. In addition to these catalogued items, Berner also does a large number of custom jobs, working with engineers and end-users to create the best possible solution for their specific applications. Berner International's other products include air entrance systems, strip doors and fabric ducts.

Berner International Corp. has been certified as a woman owned business by the Women's Business Enterprise National Council. We are members of the U.S. Green Building Association, The Green Building Alliance, The Air Movement & Control Association (AMCA), and The American Society of Heating, Refrigeration & Air Conditioning Engineers (ASHRAE). For more information on our products, please visit www.berner.com.

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