The American Swedish Institute
Minneapolis, MN

Technical Report One: ASHRAE Standard 62.1 Ventilation and Standard 90.1 Energy Design Evaluations

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Executive Summary

The American Swedish Institute, scheduled to complete construction in late spring 2012, is a 24,600 square addition and 27,500 renovation, cultural center and museum project. The building consists of multi-purpose and public spaces for the community to gain knowledge about Swedish culture. A Make-up Air Unit serves fresh air to all the spaces in the addition and existing mansion that is distributed through multiple heat pumps throughout the building. Heat pumps are supplied with water from the geothermal system located on the site of the American Swedish Institute. The American Swedish Institute is under consideration for LEED Certification throughout the construction process with a target for LEED Gold. This report will analyze the American Swedish Institute's compliance with ASHRAE Standards 62.1 and 90.1.

The report will begin with the American Swedish Institute's compliance with ASHRAE Standard 62.1 Sections 5 and 6. Section 5 of the standard covers the ventilation requirements for a building including requirements for air quality and prevention of harmful contaminants to occupants. Section 6 of the standard covers specific requirements for ventilation in a building. Overall, the American Swedish Institute complies with Standard 62.1 by exceeding the majority of requirements in Section 5 in most aspects but not being in compliance with Section 6 due to the ASHRAE assumptions of population and any rules of thumb decided by the engineer to adjust air quantities to expected values for zones.

Following the discussion of ASHRAE 62.1 is the analysis of the building as per Standard 90.1. 90.1 sets the energy standard for buildings based on their climate zone and the systems used in the building i.e., lighting, power, HVAC and building envelope. The American Swedish Institute does not comply with ASHRAE Standard 90.1. completely. All the pumps motor efficiencies are below the efficiency recommended for the specified horsepower and RPM stated in the standard. The below grade walls do not have a low enough U-value to prevent an excessive amount of heat transfer to the surrounding earth. Horsepower ratings for all the pumps throughout the American Swedish Institute are preventing compliance with this section, also.

Overall, the American Swedish Institute was in compliance with the majority of ASHRAE Standards 62.1 and 90.1. More information on these standards is provided throughout the report.

ASHRAE Standard 62.1-2007 Analysis

Section 5: Systems and Equipment

Section 5.1 Natural Ventilation

Exterior spaces have windows that are not operable, except in the mansion where the windows are only used for functional purposes and not for natural ventilation. All spaces in the mansion and cultural center, interior or exterior, are mechanically ventilated. Therefore, natural ventilation is not used for ventilation in this building.

Section 5.2 Ventilation Air Distribution

The American Swedish Institute is able to meet minimum ventilation air requirements. The construction documents state specific minimum airflow rates for each VAV air terminal that comply with Section 6 of Standard 62.1 which is discussed later in the report.

Section 5.3 Exhaust Duct Location

Exhaust ducts serving the event kitchen and café kitchen are all ducted and negatively pressurized to remove contaminants located on the roof. The type 1 hoods for the event kitchen and café are negatively pressurized to 1.4 in. w.g. relative to the surroundings. The condensate hood for the event kitchen is negatively pressurized to 0.7 in. w.g. relative to the surroundings. For the condensate hood for the café kitchen the exhaust is negatively pressurized to 1.2 in. w.g. relative to the surroundings. Exhaust fans for the American Swedish Institute are specified from 7,200 to 4,800 FPM for the event kitchen and café kitchen to maintain proper exhaust rates in those areas.

Section 5.4 Ventilation System Controls

The ventilation system controls for the American Swedish Institute allow for reduction of airflow rates to the minimum airflow rates for all VAV boxes, except for VAV boxes 0-T/4 and 0-T/5 as specified on the drawings. These VAV boxes must be maintained at the maximum airflow rates and cannot be adjusted to the minimum airflow rates. Overall, the system controls allow for almost all VAV boxes to be adjusted to minimum airflow rates as required by Section 6 in ASHRAE Standard 62.1. Therefore, the American Swedish Institute complies with this section.

Section 5.5 Airstream Surfaces

All airstream surfaces are designed in compliance with UL 181 and ASTM C 1338. The American Swedish Institute complies with this section.

Section 5.6 Outdoor Air Intakes

Significantly contaminated exhaust requires a minimum of 15 feet and truck loading area dock is a minimum of 25 feet away from outdoor intakes. Distances from all other exhaust from the building is approximately 50 feet away from each other. The distance between the loading dock and the outdoor air intake is approximately 100 feet away from each other. All exterior louvers are selected to allow zero water penetration at 700 FPM through the louver free area. All exterior wall louvers are designed and fabricated in accordance with AMCA Standard 500 which has AMCA Standards 500-L-99 and 511-99 under it and apply with the AMCA ratings program. As well as, all exterior louvers having a bird screen fixed to the interior. Rain intrusion is prevented in exterior HVAC equipment and tested via UL 1995 with suitable access doors to permit cleaning of the ventilation system. Therefore, all outdoor air intakes are more than the minimum distances apart from possible contaminant sources and comply with this section.

Section 5.7 Local Capture of Contaminants

Spaces that could potentially have contaminants affecting indoor air quality from non-combustion equipment are ducted to the roof by dedicated exhaust systems. In particular, the exhaust from the event kitchen and café kitchen spaces are ducted directly to the roof.

Section 5.8 Combustion Air

The Gas Fired Make-up Air Unit located in the loading dock is provided with a sufficient amount of air. Transfer air from other interior spaces enters the negatively pressurized loading dock through a transfer grille. All air in the loading dock exits through a relief air louver to the outdoors to allow for adequate removal of combustion products. Outside air enters through a louver, sized appropriately for the CFM of the Make-up Air Unit, on the western side of the building. The American Swedish Institute complies with this section.

Section 5.9 Particulate Matter Removal

Particulate matter filters located in air handling equipment are specified to comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV methods of testing and air-filter unit ratings. Therefore, this building complies with this section.

Section 5.10 Dehumidification Systems

The space design humidity in the American Swedish Institute is 50% in summer for all spaces, excluding mechanical and electrical rooms. In the winter the relative humidity specified for the building is set at 30% for the Art Storage, Gallery and Archive rooms with the rest of the building possibly going as low as 10% on cold winter days. Overall, the relative humidity in the American Swedish Institute is below the maximum of 65% specified in this section. Exhaust air intake airflow is less than the outdoor air intake providing a positive airflow compared to the outdoors. Therefore, the American Swedish Institute complies with this section.

Section 5.11 Drain Pans

All drain pans are specified to comply with ASHRAE Standard 62.1. Therefore, the American Swedish Institute complies with this section.

Section 5.12 Finned-Tube Coils and Heat Exchangers

Drain pans are provided beneath all heat exchangers and cooling coil assemblies in accordance with this section. No requirement was stated in the specs about access space of at least 18 in. for individual or multiple finned-tube coils.

Section 5.13 Humidifiers and Water-Spray Systems

The humidifier shall be suitable for use with pure water i.e., deionized, demineralized or reverse osmosis water. All obstructions are installed a distance equal to or greater than the absorption distance recommended by the humidifier manufacturer. The American Swedish Institute complies with this section.

Section 5.14 Access for Inspection, Cleaning, and Maintenance

HVAC equipment was specified to facilitate service and maintenance to all components for the equipment. Service clearance areas are designated on the drawings as well as rough location of equipment to allow access for maintenance. Maintaining manufacturers minimum recommended clearances around all mechanical equipment is specified on the drawings as well. Access panel's sizes are to be submitted in the submittals by the contractor to verify that the size and location are convenient and unobstructed for maintenance. Access panels are provided for all mechanical equipment, i.e. VAV boxes, humidifiers. Therefore, the American Swedish Institute complies with this section.

Section 5.15 Building Envelope and Interior Surfaces

The building envelope has a continuous moisture barrier system for below grade with the widths and lengths appropriate for this application specified by the manufacturer. Sealant, mastics and flashing are to be used as recommended by the manufacturer to seal seams and between assemblies or systems in the building. For above grade application a fluid-applied liquid air barrier is to be used. Any adhesive and sealants used to seal penetrations as recommended by the membrane manufacturer. The American Swedish Institute complies with this section.

Section 5.16 Building with Attached Parking Garages

There are no attached parking garages to the American Swedish Institute. This section does not apply.

Section 5.17 Air Classification and Recirculation

Several areas in the American Swedish Institute are classified as Class 2 air. Air from the event kitchen and café kitchen is not used for recirculation but exhausted out of the building to roof ventilators. The areas classified under this designation are janitor closets and restrooms which are exhausted out of the second floor on the western side of the building. The rest of the air is classified under Class 1 which is returned into the plenum and re-circulated through the heat pumps on each floor.

Section 5.18 Requirements for Building Containing ETS Areas and ETS-Free Areas

The American Swedish Institute functions as a museum and is applying for LEED certification therefore it is a completely smoke-free facility. This section does not apply.

Section 6: Procedures

Section 6 is to verify the American Swedish Institute's ventilation and exhaust requirements at design conditions for the Make-up Air Unit and Heat Pump Systems per ASHRAE Standard 62.1. There is only one air handling unit used in the entire building therefore, the entire building was analyzed. All the following information is referenced from ASHRAE Standard 62.1 and presented below.

Breathing Zone Outdoor Airflow (V_{bz}):

$$V_{bz} = R_p * P_z + R_a * A_z \quad \text{(Eq. 6.1)}$$

where,

A_z = zone floor area (ft²)
P_z = zone population, the largest number of people expected to occupy the zone during the zone during typical usage. (Estimated population values based on the zone floor area and the default occupant density (#/1000 ft²) found in Table 6.1)
R_p = outdoor airflow rate required per person (CFM/person) (Values from Table 6.1)
R_a = outdoor airflow rate required per unit area (CFM/ft²)

Zone Air Distribution Effectiveness (E_z):

E_z = 1.0 (ceiling supply of cool air) (Table 6.2)

Zone Outdoor Airflow (V_{oz}):

$$V_{oz} = V_{bz}/E_z \quad \text{(Eq. 6.2)}$$

Primary Outdoor Air Fraction (Z_p):

$$Z_p = V_{oz}/V_{pz} \quad \text{(Eq. 6.5)}$$

where,

V_{pz} = zone airflow primary airflow

System Ventilation Efficiency (E_v):

E_v shall be determined using Table 6.3 based off of maximum Z_p value

Uncorrected Outdoor Air Intake (V_{ou}):

$$V_{ou} = D\sum_{all\ zones}(R_p*P_z) + \sum_{all\ zones}(R_a*A_z) \quad \text{(Eq. 6.6)}$$

Occupancy Diversity (D):

$$D = P_s/\sum_{all\ zones} P_z \quad \text{(Eq. 6.7)}$$

where,

P_s = system population, is the total population in the areas served by the system

Outdoor Air Intake (Vot):

$$V_{ot} = V_{ou}/E_v \quad \text{(Eq. 6.2.6)}$$

The American Swedish Institute is comprised of a Make-up Air Unit used for outdoor air that is supplied to all the heat pumps via VAV boxes located in the building. Therefore, the Make-up Air Unit (MAU) was used for analysis of the building ventilation system. Reasoning for analyses of the MAU over the individual heat pump systems and VAV boxes was due to the fact, that the MAU provides all the fresh air to these heat pumps. The MAU was analyzed based on the specific zones for the heat pump systems since the total fresh air would be considered the same for the overall MAU or the individual heat pump systems VAV boxes added together. Also, there was not a typical zone for the building since the American Swedish Institute is a museum/cultural center with varying uses.

Appendix A contains the results on a spreadsheet from the ventilation rate procedure for the Make-up Air Unit used in the American Swedish Institute. The majority of the space's populations were calculated from ASHRAE Standard 62.1, since actual design occupancies were not known. Excluding the high density spaces i.e., studio classroom, classroom, kitchen, and event spaces. The kitchens were classified as cafeteria/fast-food dining areas since there would be a large amount of people entering and leaving the kitchen on a daily basis especially during events held in the cultural center therefore, needing more ventilation air.

Appendix B is a summary of the zones that compares the ventilation rates to design airflow rates to check for compliance with ASHRAE Standard 62.1 Section 6 analysis. Specified on the drawings the MAU is to provide 8,000 cfm of fresh outdoor air to all the heat pumps in the building. The ventilation procedure requires that 10,427 cfm of fresh outdoor air to be provided to all zones in the building which is higher than the design cfm for the American Swedish Institute. A possible reason for this could be the assumptions of the zone population based off of ASHRAE Standard 62.1 which could cause an excess of outdoor air required to those spaces that could be less or more those spaces if the program was known.

ASHRAE Standard 62.1-2007 Summary

The HVAC design of the American Swedish Institute is in compliance with Section 5 of ASHRAE Standard 62.1-2007 and in the majority of cases exceeds the minimums set by the standard. This can be contributed to the fact that the American Swedish Institute is applying for LEED certification.

The minimum ventilation requirements of the American Swedish Institute are over the 8,000 cfm designed MAU. 10,427 cfm was calculated using the ventilation rate procedure which, could have been caused by the use of ASHRAE Standard 62.1 to analyze the population for the zones. As well as the efficiency of the system as a whole being at a calculated at 74% even though, the actual efficiency of the system could be much higher. This could also be caused by adjustments done by engineers after the loads were calculated for the spaces. With these numbers being adjusted correctly for the zones and system as a whole, the ventilation air would be in compliance with ASHRAE Standard 62.1 Section 6. Since, each zone in the American Swedish Institute is in compliance with ASHRAE Standard 62.1 as soon in Appendix B.

ASHRAE Standard 90.1-2007 Analysis

Section 5: Building Envelope

5.1.4 Climate

The climate zone for the American Swedish Institute is located in Minneapolis, MN, which relates to zone 6A. Climate zone 6A experiences mixed weather conditions and periods of high humidity. The climate zone for the American Swedish Institute was determined by Figure B.1 (Figure 1 shown below) and Table B.4 in ASHRAE Standard 90.1-2007.

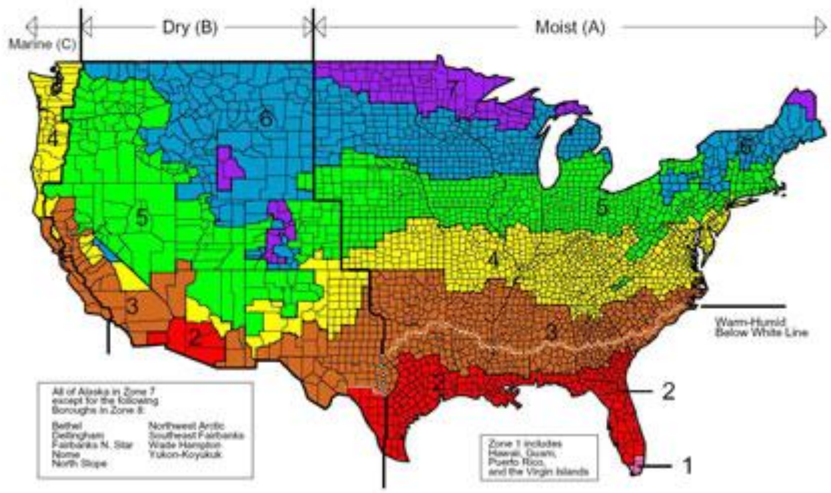

Figure 1: Climate Zones for the United Stated locations

5.4 Mandatory Provisions

The building envelope of the American Swedish Institute is specified to seal all fenestrations, exterior door frames and glazing to prevent unconditioned outdoor air from entering into the space. The main building entrances have vestibules that separate the conditioned space from the exterior space. The smallest vestibule has a space of 8 feet between the interior and exterior doors which is greater than the 7 feet specified in the standard.

5.5 Prescriptive Building Envelope Option

The prescriptive building envelope method was used to verify the American Swedish Institute's compliance with ASHRAE Standard 90.1-2007. The summary of the requirements of Section 5 of ASHRAE are shown below in Tables 1 and 2.

Section 5 of ASHRAE Standard 90.1 requires that vertical fenestration does not exceed 40% of the gross wall area of conditioned interior spaces. Since the glazing to wall ratio shown below, in Table 1, is 6.1% which is less than the 40% maximum for compliance therefore, the American Swedish Institute complies with 90.1.

	Wall Area (ft^2)	Glazing Area (ft^2)	Percent of Glazing	Compliance?
The American Swedish Institute	63340	3841	6.1%	Y

Table 1: Wall Area to Glazing Percentage

Building envelope compliance for the American Swedish Institute is shown in Table 2 below. One of the elements, walls below grade, does not pass ASHRAE Standard 90.1 for this. A reason for this, is a lack of insulation on the below grade walls which does not insulate against any heat loss to the earth. The roof and the walls above grade both are in compliance with ASHRAE 90.1 for this section and therefore, helping the American Swedish Institute in their LEED certification process.

Element	Element Construction	Non Residential ASHRAE 90.1		Non Residential ASI		Compliance?
		Assembly Maximum	*Insulation Min. R-Value*	*Assembly Maximum*	*Insulation Min. R-Value*	
Roof	Insulation Entirely Above Deck	U-0.048	R-20.0 c.i.	U-0.047	R-21.26	Y
Walls, Above Grade	Steel-Framed	U-0.104	R-9.5 c.i.	U-0.037	R-27.29	Y
Walls, Below Grade	Below-Grade Wall	C-1.140	NR	C-4.61	NR	N
Slab-On-Grade Floors	Unheated	F-.730	NR	Not Available	NR	-

Table 2: Building Envelope Properties

Section 6: Heating, Ventilating, and Air Conditioning

Additions to existing buildings, which the American Swedish Institute is classified under the mechanical equipment and systems, shall comply with this section and Standard 62.1-2007.

6.2 Compliance Paths

There are two paths for evaluation of the overall efficiency of the HVAC system: The Simplified Approach Option for HVAC Systems or the Mandatory Provisions path.

6.3 Simplified Approach Option for HVAC Systems

The Simplified Approach Method can be used if the building is two stories or less in height and has a gross floor area that is less than 25,000 ft^2. The American Swedish Institute does not meet either one of these conditions therefore; the Mandatory Provisions method will be used for this analysis.

6.4 Mandatory Provisions

The zones within the American Swedish Institute have individual thermostats for control of heating and cooling of the space. All thermostatic controls have a setpoint range of 55 to 85 degrees Fahrenheit with a 2 degree differential. With the Make-up Air Unit supplying makeup air to the heat pump systems throughout the building with a maintained constant temperature in the range of 55°F in the summer and 65°F in the winter. A DDC system is provided for control and monitoring of all mechanical equipment and systems, where programming of the system is based on day and occupancy schedule.

If the space temperature is not satisfied after a certain period of time a second heat pump cooling or heating compressor is energized to satisfy the room. The heat pumps are only energized when the room is occupied or calls for additional cooling or heating. For each thermostat there is an option for instant override of the set point temperature for continuous or timed periods.

In a fire emergency, the ventilation dampers at the top of the elevator shaft will open unless there is a loss of power then the actuator will close the damper. While under normal operation the ventilation dampers will remain closed. If a fire emergency is to occur the mechanical equipment will be signaled and shut down to avoid spreading smoke throughout the building.

The majority of plenums and ducts must be insulated regardless of whether it is supply or outdoor air. All outdoor ducts are required to have insulation regardless of location or use. The majority of supply air ducts are insulated excluding fibrous-glass ducts, any factory-insulated ducts, or metal ducts with duct liner of sufficient thickness that comply with ASHRAE 90.1. The thicknesses of duct insulation required throughout the American Swedish Institute are shown in Table 3 below.

Type of Duct	Thickness
Supply Air from MAU & heat pumps	1 in.
Outdoor Air	2 in.
Exhaust [Connections through roof or louver, 6 feet upstream]	1 in.
Louver Plenums*	2 in.
Return Air & Transfer Elbows [internally insulated]	1 in. [fiberglass with tedlar coating]

Table 3: External Duct Fiberglass Insulation

Two layers of 3M high temperature rated duct wrap must be provided for the Minneapolis requirements. This insulation is required where the ductwork is within 18 inches of combustible equipment or exiting the kitchen.

Piping insulation is located on all condensate and equipment drain water, condenser water supply and return and heating hot water supply and return regardless of size. Thicknesses of pipe insulation required in the building are shown in Table 4 below. All ductwork is to be sealed in accordance with SMACNA standards and in compliance with ASHRAE Standard 90.1.

Type of Pipe	Thickness
Hot Water Heating: 2 in. and smaller **2 1/2 in. and larger**	1 in. 1 1/2 in.
Lower Pressure Steam and Condensate Return: 2 in. and smaller **2 1/2 in. and larger**	1 1/2 in. 2 in.
Condenser Water Piping: All piping	1 in.

Table 4: External Pipe Insulation

6.5 Prescriptive Path

The geothermal heat pump systems are connected to a common geothermal and heating hot water loop. All condenser heat pumps have factory installed temperature controls to prevent overlap between setpoints. For refrigerant to water heat exchangers used in the heat pump system water regulating valves are utilized. The valves limit water flow through the heat exchanger while controlling head pressure during cooling or heating operation. This allows for the system to use lower temperature ground source water, permitting a range of entering water temperatures from 25 to 125 degrees Fahrenheit. Therefore, by using lower temperature water, energy usage is decreased during normal operating hours for the American Swedish

Institute. All the heat pumps are provided with a two-position automatic value to shut off water flow when the compressor is not running.

Using the Motor Nameplate Horsepower for calculating fan system power, all of the fans are in compliance with this section of 90.1. Table 5 provides a summary of the calculation for maximum fan power horsepower for the fans in the American Swedish Institute.

Fan Compliance				
Fan No.	HP	CFM	CFM*0.0015 (Variable Volume)	Compliance ?
MAU-1	2 @ 7 1/2	8,000	12	**Y**
MAU-2	3/4 (3)	4,400	6.6	**Y**
E-1	1 1/2	2,120	3.18	**Y**
E-2	1/4	280	0.42	**Y**
E-3	1	1,300	1.95	**Y**
E-4	-	140	-	**-**
E-5	1/4	400	0.6	**Y**
E-6	1 (3/4)	1,100	1.65	**Y**
E-7	1/4	400	0.6	**Y**
PRV-1	2	4,400	6.6	**Y**
PRV-2	3/4	1,450	2.18	**Y**
PRV-3	1/4	900	1.35	**Y**
PRV-4	1/2	900	1.35	**Y**

Table 5: Fan Compliance

6.7 Submittals

For the American Swedish Institute construction documents that include the sequence of operations and the building operating and maintenance manuals will be provided to the building owners. All reports after calibration and balancing for hydronic and air systems will be handed over to the owners upon completion. Commissioning on all equipment and systems shall be done by an independent agent to verify operation of all systems for LEED certification.

Section 7: Service Water Heating

Existing water services from a 6 and 12 inch watermain located along the adjacent streets will be used to provide water services to the site. The existing boilers are still in use to provide heating for the water services. Therefore, the addition is provided by the existing water heating systems equipment and is in compliance with 90.1.

Section 8: Power

Power to the American Swedish Institute is required to comply with NFPA 70 and the National Electric Code (NEC). This states that feeder conductors shall have a maximum voltage drop of 2% and a maximum of 3% voltage drop for branch circuits. Single-line diagrams and schedules are included in the construction documents and will be given to the building owner at the completion of the project. Thus, the American Swedish Institute complies with this section of 90.1.

Section 9: Lighting

9.2 Compliance Path

In Standard 90.1 there are two methods that can used to determine the maximum lighting power allowance for the building: The Building Area Method or the Space-by-Space Method. The simplified Building Area Method will be used to calculate the lighting power allowance for the American Swedish Institute. The Building Area Method uses the determined gross lighted floor area multiplied by the lighting power density to calculate the lighting power allowances which, is then summed to give the total lighting power allowances for the building.

9.4 Mandatory Provisions

Rooms less than 1,000 square feet are provided with occupancy sensors to automatically control lighting through the American Swedish Institute. Space control is provided in all work and office areas to allow occupant selection of lighting levels. Daylighting control capabilities are provided for lobbies and public spaces to decrease the usage of lighting during optimal daylighting periods.

9.5 Building Area Method Compliance Path

The American Swedish Institute is classified as a museum building area type from Table 9.5.1 in ASHRAE Standard 90.1 with a maximum lighting power density of 1.1 W/ft^2. The building has over 85 different types of lighting fixtures in the building therefore, only a portion of the building was selected for this calculation to check compliance with Standard 90.1. The lower floor of the addition is 0.42 W/SF and is in compliance with 90.1 therefore, the assumption of the whole building being in compliance is made. The lighting power density compliance check is shown in Table 6 below.

Fixture	Lower	W/fixture	Total W
NF1-3	14	58	812
NF1-9	2	58	116
NF3-3	10	58	580
NF3-5	28	58	1624
NF3-7	2	58	116
NF3-9	18	58	1044
NF3-11	6	58	348
NF4-3	12	58	696
NF5-8	1	58	58
NF7-3	3	58	174
		Total	5568
		Building Area	12300
		W/SF	0.42
		Compliance	Y

Table 6: Lighting Power Density Compliance

Section 10: Other Equipment

All other equipment with motors is under compliance with this section, that rates motors based on efficiency which is determined by horsepower and RPM of the motor. None of the motors listed in Table 7 below in the American Swedish Institute are in compliance with this section in Standard 90.1. All the motors listed in this table have the option to operate at variable speeds depending on the load on the motor for the pumps.

Pump	System	HP	Efficiency %	RPM	Minimum Efficiency	Compliance?
CWP-1	Primary Condenser Water Pump (PCWP)	20	68.4	1750	91	**N**
CWP-2	PCWP (Standby)	20	68.4	1750	91	**N**
CWP-3	Secondary Condenser Water Pump (SCWP)	25	72.7	1750	91.7	**N**
CWP-4	SCWP (Standby)	25	72.7	1750	91.7	**N**
HWP-1	Heating Hot Water (HHW)	7.5	69.4	1750	88.5	**N**
HWP-2	HHW (Standby)	7.5	69.4	1750	88.5	**N**
HWP-3	Snowmelt	1	40.1	1750	82.5	**N**

Table 7: Pump Motor Efficiency Compliance

ASHRAE Standard 90.1-2007 Summary

To determine the compliance of the American Swedish Institute with ASHRAE Standard 90.1-2007 the prescriptive method was used under all applicable sections. Overall, the American Swedish Institute is in compliance with standard with a few exceptions. The two sections that do not comply fully with Standard 90.1 are building envelope properties and pump motor efficiency. The below grade walls are not in compliance with standard since there is a lack of insulation for those walls and with a simple addition of insulation the heat transfer could be corrected. All the pumps have Variable Speed Drives to adjust the RPM for the required load.

The American Swedish Institute has submitted an application for LEED certification with a maximum potential of receiving LEED Gold at the end of construction. Therefore, the overall energy efficiency of the American Swedish Institute was a major design consideration throughout the project with almost complete compliance with ASHRAE Standard 90.1. Compliance with the standard could be reached with a few minor adjustments to the building envelope and horsepower for the Make-up Air Unit.

References

ANSI/ASHRAE Standard 62.1-2007, *Ventilation for Acceptable Indoor Air Quality*. Atlanta Georgia: American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc.

ANSI/ASHRAE Standard 90.1-2007, *Energy Standard for Buildings Except Low-Rise Residential Buildings*. Atlanta, Georgia: American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc.

HGA Architects and Engineer. Architectural Construction Documents. HGA Architects and Engineers, Minneapolis, MN.

HGA Architects and Engineer. Electrical Construction Documents. HGA Architects and Engineers, Minneapolis, MN.

HGA Architects and Engineer. Mechanical Construction Documents. HGA Architects and Engineers, Minneapolis, MN.

Appendix A – Ventilation Rate Procedure

Building:	The American Swedish Institute									
System Tag/Name:	MAU - 1 and heat pump systems									
Operating Condition Description:	Design Peak Cooling Load Condition									
Units (select from pull-down list)	IP									
Inputs for System	**Name**	**Units**		**System**						
Floor area served by system	As	sf		34725						
Population of area served by system (including diversity)	Ps	P	100% diversity	808						
Design primary supply fan airflow rate	Vpsd	cfm		48,880						
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.09						
OA req'd per person for system area (Weighted average)	Rps	cfm/p		5.8						
Inputs for Potentially Critical zones										
Zone Name					Electrical/Telecom	Mechanical	Elev Equip Room	Quarantine & Table/Chair, Kitchen Storage and Corridor	Building Engineer	Elev Equip Room
Zone Tag			*Zone title turns purple italic for critical zone(s)*		0A-1	0A-2	0A-3	0A-4	0A-6	0A-8
Space type			Select from pull-down list		Electrical equipment rooms	Corridors	Elevator machine rooms	Storage rooms	Office space	Elevator machine rooms
Floor Area of zone	Az	sf			400	565	50	320	150	100
Design population of zone	Pz	P	(default value listed; may be overridden)		0	0	0	0	0.75	0
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			1,000	300	630	630	300	1000
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?			Select from pull-down list or leave blank if N/A							
Local recirc. air % representative of ave system return air	Er									
Inputs for Operating Condition Analyzed										
Percent of total design airflow rate at conditioned analyzed	Ds	%		100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed			Select from pull-down list		CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep									
Results										
Ventilation System Efficiency	Ev			0.74						
Outdoor air intake required for system	Vot	cfm		10427						
Outdoor air per unit floor area	Vot/As	cfm/sf		0.30						
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		12.9						
Outdoor air as a % of design primary supply air	Ypd	cfm		21%						
Detailed Calculations										
Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs	= 48880						
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As	= 7747						
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps	= 0.16						
Initial Calculations for individual zones										
OA rate per unit area for zone	Raz	cfm/sf			0.06	0.06	0.12	0.12	0.06	0.12
OA rate per person	Rpz	cfm/p			0.00	0.00	0.00	0.00	5.00	0.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			1000	300	630	630	300	1000
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az	=	24.0	33.9	6.0	38.4	12.8	12.0
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez	=	24	34	6	38	13	12
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er	=	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep	=	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er)	=	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz	=	0.02	0.11	0.01	0.06	0.04	0.01
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz	=	0.02	0.11	0.01	0.06	0.04	0.01
System Ventilation Efficiency										
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa	=	1.13	1.05	1.15	1.10	1.12	1.15
System Ventilation Efficiency (App A Method)	Ev		= min (Evz)	= 0.74						
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3	= 0.73						
Minimum outdoor air intake airflow										
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev	= 10427						
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps	= 0.21						
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev	= 10548						
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps	= 0.22						
OA Temp at which Min OA provides all cooling										
OAT below which OA intake flow is @ minimum		Deg F	= {(Tp-dTsf)-(1-Y)*(Tr+dTrf	= -8						

Building:	**The American Swedish Institute**									
System Tag/Name:	**MAU - 1 and heat pump systems**									
Operating Condition Description:	**Design Peak Cooling Load Condition**									
Units (select from pull-down list)	**IP**									
Inputs for System	**Name**	**Units**		**System**						
Floor area served by system	As	sf		34725						
Population of area served by system (including diversity)	Ps	P	100% diversity	808						
Design primary supply fan airflow rate	Vpsd	cfm		48,880						
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.09						
OA req'd per person for system area (Weighted average)	Rps	cfm/p		5.8						
Inputs for Potentially Critical zones										
Zone Name					Storage, Maint Storage, & Maint Shop	Collection Storage	Corridor, Work & Material Storage	Retail Work Storage	Studio Classroom	Gust Exterior Offices
Zone Tag			*Zone title turns purple italic for critical zone(s)*		OA-7	OA-8	OA-9	OA-10	1A-1	1A-2
Space type			Select from pull-down list		Storage rooms	Storage rooms	Office space	Storage rooms	Lecture classroom	Office space
Floor Area of zone	Az	sf			685	2400	685	1020	780	235
Design population of zone	Pz	P	(default value listed; may be overridden)		0	0	3.425	0	20	1.175
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			1000	1200	1000	630	1000	400
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?			Select from pull-down list or leave blank if N/A							
Local recirc. air % representative of ave system return air	Er				75%	75%	75%	75%	75%	75%
Inputs for Operating Condition Analyzed										
Percent of total design airflow rate at conditioned analyzed	Ds	%		100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed			Select from pull-down list		CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep									
Results										
Ventilation System Efficiency	Ev			0.74						
Outdoor air intake required for system	Vot	cfm		10427						
Outdoor air per unit floor area	Vot/As	cfm/sf		0.30						
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		12.8						
Outdoor air as a % of design primary supply air	Ypd	cfm		21%						
Detailed Calculations										
Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs =	48880						
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As =	7747						
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.16						
Initial Calculations for individual zones										
OA rate per unit area for zone	Raz	cfm/sf			0.12	0.12	0.06	0.12	0.06	0.06
OA rate per person	Rpz	cfm/p			0.00	0.00	5.00	0.00	7.50	5.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			1000	1200	1000	630	1000	400
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		82.2	288.0	58.2	122.4	196.8	20.0
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		82	288	58	122	197	20
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er =		1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep =		1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er) =		1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.08	0.24	0.06	0.19	0.20	0.05
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.08	0.24	0.06	0.19	0.20	0.05
System Ventilation Efficiency										
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		1.08	0.92	1.10	0.96	0.96	1.11
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	0.74						
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3 =	0.73						
Minimum outdoor air intake airflow										
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev =	10427						
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	0.21						
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev =	10548						
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps =	0.22						
OA Temp at which Min OA provides all cooling										
OAT below which OA intake flow is @ minimum		Deg F	= {(Tp-dTsf)-(1-Y)*(Tr+dTr =	-8						

Building:	The American Swedish Institute									
System Tag/Name:	MAU - 1 and heat pump systems									
Operating Condition Description:	Design Peak Cooling Load Condition									
Units (select from pull-down list)	IP									
Inputs for System	**Name**	**Units**		**System**						
Floor area served by system	As	sf		34725						
Population of area served by system (including diversity)	Ps	P	100% diversity	808						
Design primary supply fan airflow rate	Vpsd	cfm		48,880						
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.09						
OA req'd per person for system area (Weighted average)	Rps	cfm/p		5.8						
Inputs for Potentially Critical zones										
Zone Name					Waiting/Conference/Reception/Printer	Hallways	Hallways, Restrooms	Multi-Purpose, Hallway	Catering Support, Shipping & Receiving	Kitchen, Storage
Zone Tag			*Zone title turns purple italic for critical zone(s)*		1A-3	1A-4	1A-6	1A-8	1A-7	1A-8
Space type		Select from pull-down list			Office space	Corridors	Corridors	Office space	Office space	Cafeteria/fast-food dining
Floor Area of zone	Az	sf			440	860	920	715	295	1130
Design population of zone	Pz	P	(default value listed; may be overridden)		2.2	0	0	3.575	1.475	12
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			630	1600	630	400	400	1400
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A								
Local recirc. air % representative of ave system return air	Er									
Inputs for Operating Condition Analyzed										
Percent of total design airflow rate at conditioned analyzed	Ds	%		100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed		Select from pull-down list			CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep									
Results										
Ventilation System Efficiency	Ev			0.74						
Outdoor air intake required for system	Vot	cfm		10427						
Outdoor air per unit floor area	Vot/As	cfm/sf		0.30						
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		12.9						
Outdoor air as a % of design primary supply air	Ypd	cfm		21%						
Detailed Calculations										
Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs =	48880						
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As =	7747						
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.16						
Initial Calculations for individual zones										
OA rate per unit area for zone	Raz	cfm/sf			0.06	0.06	0.06	0.06	0.06	0.18
OA rate per person	Rpz	cfm/p			5.00	0.00	0.00	5.00	5.00	7.50
Total supply air to zone (at condition being analyzed)	Vdz	cfm			630	1600	630	400	400	1400
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		37.4	51.6	55.2	60.8	25.1	293.4
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		37	52	55	61	25	293
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er =		1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep =		1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er) =		1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.06	0.03	0.09	0.15	0.06	0.21
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.06	0.03	0.09	0.15	0.06	0.21
System Ventilation Efficiency										
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		1.10	1.13	1.07	1.01	1.10	0.95
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	0.74						
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3 =	0.73						
Minimum outdoor air intake airflow										
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev =	10427						
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	0.21						
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev =	10548						
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps =	0.22						
OA Temp at which Min OA provides all cooling										
OAT below which OA intake flow is @ minimum		Deg F	= {(Tp-dTsf)-(1-Y)*(Tr+dTr =	-8						

Building:	**The American Swedish Institute**									
System Tag/Name:	**MAU - 1 and heat pump systems**									
Operating Condition Description:	**Design Peak Cooling Load Condition**									
Units (select from pull-down list)	**IP**									
Inputs for System	**Name**	**Units**		**System**						
Floor area served by system	As	sf		34725						
Population of area served by system (including diversity)	Ps	P	100% diversity	808						
Design primary supply fan airflow rate	Vpsd	cfm		48,880						
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.09						
OA req'd per person for system area (Weighted average)	Rps	cfm/p		5.8						
Inputs for Potentially Critical zones										Potentially C
Zone Name			*Zone title turns purple italic for critical zone(s)*		*Café Room*	Conference	Gallery	Reception, Storage, Office	Gift Shop	Lobby
Zone Tag					1A-9	1A-10	1A-11	1A-12	1A-13	1A-14
Space type			Select from pull-down list		Cafeteria/fast-food dining	Conference/meeting	Museums/galleries	Office space	Sales (except as below)	Lobbies
Floor Area of zone	Az	sf			1700	1000	1075	390	850	630
Design population of zone	Pz	P	(default value listed; may be overridden)		70	25	15	1.95	12.75	94.5
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			2000	2000	1400	400	2000	1400
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?			Select from pull-down list or leave blank if N/A							
Local recirc. air % representative of ave system return air	Er				75%	75%	75%	75%	75%	75%
Inputs for Operating Condition Analyzed										
Percent of total design airflow rate at conditioned analyzed	Ds	%		100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed			Select from pull-down list		CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep									
Results										
Ventilation System Efficiency	Ev			0.74						
Outdoor air intake required for system	Vot	cfm		10427						
Outdoor air per unit floor area	Vot/As	cfm/sf		0.30						
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		12.9						
Outdoor air as a % of design primary supply air	Ypd	cfm		21%						
Detailed Calculations										
Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs =	48880						
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As =	7747						
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.16						
Initial Calculations for Individual zones										
OA rate per unit area for zone	Raz	cfm/sf			0.18	0.06	0.06	0.06	0.12	0.06
OA rate per person	Rpz	cfm/p			7.50	5.00	7.50	5.00	7.50	5.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			2000	2000	1400	400	2000	1400
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		831.0	185.0	177.0	33.2	197.6	510.3
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		831	185	177	33	198	510
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er =		1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep =		1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er) =		1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.42	0.09	0.13	0.08	0.10	0.36
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.42	0.09	0.13	0.08	0.10	0.36
System Ventilation Efficiency										
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		0.74	1.07	1.03	1.08	1.06	0.79
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	0.74						
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3 =	0.73						
Minimum outdoor air intake airflow										
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev =	10427						
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	0.21						
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev =	10548						
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps =	0.22						
OA Temp at which Min OA provides all cooling										
OAT below which OA intake flow is @ minimum		Deg F	= {(Tp-dTsf)-(1-Y)*(Tr+dTrf =	-8						

	Name	Units		System	Lobby	Cost, Storage, Restrooms	Hallways	Prefunction	North Event Space	Center Event Space
Building:	The American Swedish Institute									
System Tag/Name:	MAU - 1 and heat pump systems									
Operating Condition Description:	Design Peak Cooling Load Condition									
Units (select from pull-down list)	IP									
Inputs for System	**Name**	**Units**		**System**						
Floor area served by system	As	sf		34725						
Population of area served by system (including diversity)	Ps	P	100% diversity	808						
Design primary supply fan airflow rate	Vpsd	cfm		48,880						
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.09						
OA req'd per person for system area (Weighted average)	Rps	cfm/p		5.8						
Inputs for Potentially Critical zones					Critical Zones					
Zone Name					Lobby	Cost, Storage, Restrooms	Hallways	Prefunction	North Event Space	Center Event Space
	Zone title turns purple italic for critical zone(s)									
Zone Tag					1A-16	2A-1	2A-2	2A-3	2A-4	2A-5
Space type					Lobbies	Corridors	Corridors	Lobbies/prefunction	Multipurpose assembly	Multipurpose assembly
		Select from pull-down list								
Floor Area of zone	Az	sf			630	920	460	1280	1280	1300
Design population of zone	Pz	P	(default value listed; may be overridden)		94.5	0	0	38.4	85	85
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			1400	630	400	1600	2000	2000
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A								
Local recirc. air % representative of ave system return air	Er				75%	75%	75%	75%	75%	75%
Inputs for Operating Condition Analyzed										
Percent of total design airflow rate at conditioned analyzed	Ds	%		100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed		Select from pull-down list			CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep									
Results										
Ventilation System Efficiency	Ev			0.74						
Outdoor air intake required for system	Vot	cfm		10427						
Outdoor air per unit floor area	Vot/As	cfm/sf		0.30						
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		12.9						
Outdoor air as a % of design primary supply air	Ypd	cfm		21%						
Detailed Calculations										
Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs	= 48880						
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As	= 7747						
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps	= 0.16						
Initial Calculations for individual zones										
OA rate per unit area for zone	Raz	cfm/sf			0.06	0.06	0.06	0.06	0.06	0.06
OA rate per person	Rpz	cfm/p			5.00	0.00	0.00	7.50	5.00	5.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			1400	630	400	1600	2000	2000
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az	=	510.3	55.2	27.6	364.8	501.8	503.0
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez	=	510	55	28	365	502	503
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er	=	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep	=	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er)	=	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz	=	0.36	0.09	0.07	0.23	0.25	0.25
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz	=	0.36	0.09	0.07	0.23	0.25	0.25
System Ventilation Efficiency										
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa	=	0.79	1.07	1.09	0.93	0.91	0.91
System Ventilation Efficiency (App A Method)	Ev		= min (Evz)	= 0.74						
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3	= 0.73						
Minimum outdoor air intake airflow										
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev	= 10427						
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps	= 0.21						
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev	= 10548						
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps	= 0.22						
OA Temp at which Min OA provides all cooling										
OAT below which OA intake flow is @ minimum		Deg F	= {(Tp-dTsf)-(1-Y)*(Tr+dTr	= -8						

Building:	The American Swedish Institute									
System Tag/Name:	MAU - 1 and heat pump systems									
Operating Condition Description:	Design Peak Cooling Load Condition									
Units (select from pull-down list)	IP									
Inputs for System	**Name**	**Units**		**System**						
Floor area served by system	As	sf		34725						
Population of area served by system (including diversity)	Ps	P	100% diversity	808						
Design primary supply fan airflow rate	Vpsd	cfm		48,880						
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.09						
OA req'd per person for system area (Weighted average)	Rps	cfm/p		5.8						
Inputs for Potentially Critical zones										
Zone Name					South Event Space	Kitchen	Kitchen, Hallway	Hallway, Community	Classroom, Hallway	Classroom, Hallway
			Zone title turns purple italic for critical zone(s)							
Zone Tag					2A-8	2A-7	2A-8	0T-1	0T-2	0T-3
Space type			Select from pull-down list		Multipurpose assembly	Cafeteria/fast-food dining	Cafeteria/fast-food dining	Multipurpose assembly	Lecture classroom	Lecture classroom
Floor Area of zone	Az	sf			1310	515	400	820	520	640
Design population of zone	Pz	P	(default value listed; may be overridden)		30	4	4	45	25	25
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			2000	1000	1000	1200	1000	1000
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?			Select from pull-down list or leave blank if N/A							
Local recirc. air % representative of ave system return air	Er				75%	75%	75%	75%	75%	75%
Inputs for Operating Condition Analyzed										
Percent of total design airflow rate at conditioned analyzed	Ds	%		100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed			Select from pull-down list		CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep									
Results										
Ventilation System Efficiency	Ev			0.74						
Outdoor air intake required for system	Vot	cfm		10427						
Outdoor air per unit floor area	Vot/As	cfm/sf		0.30						
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		12.9						
Outdoor air as a % of design primary supply air	Ypd	cfm		21%						
Detailed Calculations										
Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs =	48880						
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As =	7747						
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.16						
Initial Calculations for individual zones										
OA rate per unit area for zone	Raz	cfm/sf			0.06	0.18	0.18	0.06	0.06	0.06
OA rate per person	Rpz	cfm/p			5.00	7.50	7.50	5.00	7.50	7.50
Total supply air to zone (at condition being analyzed)	Vdz	cfm			2000	1000	1000	1200	1000	1000
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		228.6	122.7	102.0	274.2	218.7	225.9
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		229	123	102	274	219	226
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er =		1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep =		1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er) =		1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.11	0.12	0.10	0.23	0.22	0.23
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.11	0.12	0.10	0.23	0.22	0.23
System Ventilation Efficiency										
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		1.04	1.04	1.06	0.93	0.94	0.93
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	0.74						
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3 =	0.73						
Minimum outdoor air intake airflow										
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev =	10427						
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	0.21						
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev =	10548						
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps =	0.22						
OA Temp at which Min OA provides all cooling										
OAT below which OA intake flow is @ minimum		Deg F	= {(Tp-dTsf)-(1-Y)*(Tr+dTr =	-8						

Building:	The American Swedish Institute			
System Tag/Name:	MAU - 1 and heat pump systems			
Operating Condition Description:	Design Peak Cooling Load Condition			
Units (select from pull-down list)	IP			

	Name	Units	Formula / Note	System	Hallway, Community	Kitchen	Volunteer Lounge	Hallways, Storage, Restrooms	Elev Equip	Links
Inputs for System										
Floor area served by system	As	sf		34725						
Population of area served by system (including diversity)	Ps	P	100% diversity	808						
Design primary supply fan airflow rate	Vpsd	cfm		48,880						
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.09						
OA req'd per person for system area (Weighted average)	Rps	cfm/p		5.8						
Inputs for Potentially Critical zones										
Zone Name			*Zone title turns purple italic for critical zone(s)*		Hallway, Community	Kitchen	Volunteer Lounge	Hallways, Storage, Restrooms	Elev Equip	Links
Zone Tag					0T-4	0T-5	0T-6	0T-7	0T-8	0T-9
Space type			Select from pull-down list		Multipurpose assembly	Cafeteria/fast-food dining	Conference/meeting	Corridors	Elevator machine rooms	Corridors
Floor Area of zone	Az	sf			820	200	770	1300	100	395
Design population of zone	Pz	P	(default value listed; may be overridden)		45	4	10	0	0	0
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			1200	400	800	1000	1200	1000
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?			Select from pull-down list or leave blank if N/A							
Local recirc. air % representative of ave system return air	Er									
Inputs for Operating Condition Analyzed										
Percent of total design airflow rate at conditioned analyzed	Ds	%		100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed			Select from pull-down list		CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep									
Results										
Ventilation System Efficiency	Ev			0.74						
Outdoor air intake required for system	Vot	cfm		10427						
Outdoor air per unit floor area	Vot/As	cfm/sf		0.30						
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		12.9						
Outdoor air as a % of design primary supply air	Ypd	cfm		21%						
Detailed Calculations										
Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs =	48880						
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As =	7747						
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.16						
Initial Calculations for individual zones										
OA rate per unit area for zone	Raz	cfm/sf			0.06	0.18	0.06	0.06	0.12	0.06
OA rate per person	Rpz	cfm/p			5.00	7.50	5.00	0.00	0.00	0.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			1200	400	800	1000	1200	1000
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		274.2	66.0	96.2	78.0	12.0	23.7
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		274	66	96	78	12	24
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er =		1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep =		1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er) =		1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.23	0.17	0.12	0.08	0.01	0.02
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.23	0.17	0.12	0.08	0.01	0.02
System Ventilation Efficiency										
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		0.93	0.99	1.04	1.08	1.15	1.13
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	0.74						
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3 =	0.73						
Minimum outdoor air intake airflow										
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev =	10427						
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	0.21						
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev =	10548						
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps =	0.22						
OA Temp at which Min OA provides all cooling										
OAT below which OA intake flow is @ minimum		Deg F	= {(Tp-dTsf)-(1-Y)*(Tr+dTr =	-8						

Building:	The American Swedish Institute									
System Tag/Name:	MAU - 1 and heat pump systems									
Operating Condition Description:	Design Peak Cooling Load Condition									
Units (select from pull-down list)	IP									
Inputs for System	**Name**	**Units**		**System**						
Floor area served by system	As	sf		34725						
Population of area served by system (including diversity)	Ps	P	100% diversity	808						
Design primary supply fan airflow rate	Vpsd	cfm		48,880						
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.09						
OA req'd per person for system area (Weighted average)	Rps	cfm/p		5.8						
Inputs for Potentially Critical zones										
Zone Name					Links	Archive, Storage	Gallery	Library	Storage	Work Room
Zone Tag			*Zone title turns purple italic for critical zone(s)*		0T-10	0T-11	0T-12	0T-13	0T-14	1T-1
Space type			Select from pull-down list		Corridors	Storage rooms	Museums/galleries	Libraries	Storage rooms	Storage rooms
Floor Area of zone	Az	sf			320	1190	1100	500	280	280
Design population of zone	Pz	P	(default value listed; may be overridden)		0	0	44	5	0	0
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			800	800	1400	300	400	1000
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?			Select from pull-down list or leave blank if N/A							
Local recirc. air % representative of ave system return air	Er				75%	75%	75%	75%	75%	75%
Inputs for Operating Condition Analyzed										
Percent of total design airflow rate at conditioned analyzed	Ds	%		100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed			Select from pull-down list		CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep									
Results										
Ventilation System Efficiency	Ev			0.74						
Outdoor air intake required for system	Vot	cfm		10427						
Outdoor air per unit floor area	Vot/As	cfm/sf		0.30						
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		12.9						
Outdoor air as a % of design primary supply air	Ypd	cfm		21%						
Detailed Calculations										
Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs	= 48880						
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As	= 7747						
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps	= 0.16						
Initial Calculations for individual zones										
OA rate per unit area for zone	Raz	cfm/sf			0.06	0.12	0.06	0.12	0.12	0.12
OA rate per person	Rpz	cfm/p			0.00	0.00	7.50	5.00	0.00	0.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			800	800	1400	300	400	1000
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az	=	19.2	142.8	396.0	85.0	33.6	33.6
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez	=	19	143	396	85	34	34
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er	=	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep	=	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er)	=	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz	=	0.02	0.18	0.28	0.28	0.08	0.03
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz	=	0.02	0.18	0.28	0.28	0.08	0.03
System Ventilation Efficiency										
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa	=	1.13	0.98	0.88	0.88	1.07	1.12
System Ventilation Efficiency (App A Method)	Ev		= min (Evz)	= 0.74						
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3	= 0.73						
Minimum outdoor air intake airflow										
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev	= 10427						
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps	= 0.21						
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev	= 10548						
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps	= 0.22						
OA Temp at which Min OA provides all cooling										
OAT below which OA intake flow is @ minimum		Deg F	= {(Tp-dTsf)-(1-Y)*(Tr+dTr	= -8						

Building:	The American Swedish Institute					
System Tag/Name:	MAU - 1 and heat pump systems					
Operating Condition Description:	Design Peak Cooling Load Condition					
Units (select from pull-down list)	IP					
Inputs for System	**Name**	**Units**		**System**	**Check Figures**	
Floor area served by system	As	sf		34725		
Population of area served by system (including diversity)	Ps	P	100% diversity	808	23.3 P/1000 sf	
Design primary supply fan airflow rate	Vpsd	cfm		48,880	1.41 cfm/sf	
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.09	0.09 ave cfm/sf	
OA req'd per person for system area (Weighted average)	Rps	cfm/p		5.8	5.85 ave cfm/p	
Inputs for Potentially Critical zones						
Zone Name						
	Zone title turns purple italic for critical zone(s)				Totals/averages	
Zone Tag						
Space type		Select from pull-down list				
Floor Area of zone	Az	sf			34725 total sf	
Design population of zone	Pz	P	(default value listed; may be overridden)		807.7 total P	
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			48880 total cfm	
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A				
Local recirc. air % representative of ave system return air	Er				1.00 average	
Inputs for Operating Condition Analyzed						
Percent of total design airflow rate at conditioned analyzed	Ds	%		100%	100% average	make that
Air distribution type at conditioned analyzed		Select from pull-down list				
Zone air distribution effectiveness at conditioned analyzed	Ez				100% average	Primary airflow rate to zones
Primary air fraction of supply air at conditioned analyzed	Ep				1.00 average	48880 cfm
Results						
Ventilation System Efficiency	Ev			0.74		
Outdoor air intake required for system	Vot	cfm		10427		
Outdoor air per unit floor area	Vot/As	cfm/sf		0.30		
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		12.9		
Outdoor air as a % of design primary supply air	Ypd	cfm		21%		
Detailed Calculations						
Initial Calculations for the System as a whole						
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs	= 48880	807.7 System population without diversity	
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As	= 7747	1.00 System population diversity, D	
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps	= 0.16		
Initial Calculations for individual zones						
OA rate per unit area for zone	Raz	cfm/sf				
OA rate per person	Rpz	cfm/p				
Total supply air to zone (at condition being analyzed)	Vdz	cfm			48880	
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az	=	7747	
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez	=	7747	
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er	=		
Fraction of zone supply from fully mixed primary air	Fb		= Ep	=		
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er)	=		
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz	=	0.42 Maximum Zd	
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz	=	0.42 Maximum Zp	
System Ventilation Efficiency						
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa	=		
System Ventilation Efficiency (App A Method)	Ev		= min (Evz)	= 0.74		
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3	= 0.73		
Minimum outdoor air intake airflow						
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev	= 10427		
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps	= 0.21		
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev	= 10548		
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps	= 0.22		
OA Temp at which Min OA provides all cooling						
OAT below which OA intake flow is @ minimum		Deg F	= {(Tp-dTsf)-(1-Y)*(Tr+dTri	= -8		

Appendix B – Minimum Ventilation Compliance Check

Tag	Name	Level	Area	Design Ventilation	Minimum Ventilation	Compliance?
0A-1	Electrical/Telecom	Lower	400	1000	24	Y
0A-2	Mechanical	Lower	565	300	34	Y
0A-3	Elev Equip Room	Lower	50	630	6	Y
0A-4	Quarantine & Table/Chair, Kitchen Storage, Corridor	Lower	320	630	38	Y
0A-5	Building Engineer	Lower	150	300	13	Y
0A-6	Elev Equip Room	Lower	100	1000	12	Y
0A-7	Storage, Maint Storage, Maint Shop	Lower	685	1000	82	Y
0A-8	Collection Storage	Lower	2400	1200	288	Y
0A-9	Corridor, Work, Material Storage	Lower	685	1000	58	Y
0A-10	Retail Work Storage	Lower	1020	630	122	Y
1A-1	Studio Classroom	First	780	400	197	Y
1A-2	Gust Exterior Offices	First	235	400	20	Y
1A-3	Waiting/Conference/Reception/Printer	First	440	630	37	Y
1A-4	Hallways	First	860	1600	52	Y
1A-5	Hallways, Restrooms	First	920	630	55	Y
1A-6	Multi-purpose, Hallway	First	715	400	61	Y
1A-7	Catering Support, Shipping & Receiving	First	295	400	25	Y
1A-8	Kitchen, Storage	First	1130	1400	293	Y
1A-9	Café Room	First	1700	2000	831	Y
1A-10	Conference	First	1000	2000	185	Y
1A-11	Gallery	First	1075	1400	177	Y
1A-12	Reception, Storage, Office	First	390	400	33	Y
1A-13	Gift Shop	First	850	2000	198	Y
1A-14	Lobby	First	630	1400	510	Y
1A-15	Lobby	First	630	1400	510	Y
2A-1	Coat, Storage, Restrooms	Second	920	630	55	Y
2A-2	Hallways	Second	460	400	28	Y
2A-3	Prefunction	Second	1280	1600	365	Y
2A-4	North Event Space	Second	1280	2000	502	Y
2A-5	Center Event Space	Second	1300	2000	503	Y
2A-6	South Event Space	Second	1310	2000	229	Y
2A-7	Kitchen	Second	515	1000	123	Y
2A-8	Kitchen, Hallway	Second	400	1000	102	Y
0T-1	Hallway, Community	Lower	820	1200	274	Y
0T-2	Classroom, Hallway	Lower	520	1000	219	Y
0T-3	Classroom, Hallway	Lower	640	1000	226	Y
0T-4	Hallway, Community	Lower	820	1200	274	Y
0T-5	Kitchen	Lower	200	400	66	Y
0T-6	Volunteer Lounge	Lower	770	800	96	Y
0T-7	Hallways, Storage, Restrooms	Lower	1300	1000	78	Y
0T-8	Elev Equip Room	Lower	100	1200	12	Y
0T-9	Links	Lower	395	1000	24	Y

0T-10	Links	Lower	320	800	19	**Y**
0T-11	Archive, Storage	Lower	1190	800	143	**Y**
0T-12	Gallery	Lower	1100	1400	396	**Y**
0T-13	Library	Lower	500	300	85	**Y**
0T-14	Storage	Lower	280	400	34	**Y**
1T-1	Work Room	First	280	1000	34	**Y**