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 multipurpose 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}):

$$V_{bz} = R_p * P_z + R_a * A_z$$

(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)
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Zone Outdoor Airflow (V_{oz}):

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

Primary Outdoor Air Fraction (Z_p):

$$Z_{p} = V_{oz}/V_{pz}$$
(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 (Vou):

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

Occupancy Diversity (D):

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

where,

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

Outdoor Air Intake (Vot):

$$V_{ot} = V_{ou}/E_v$$

(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/fastfood 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.

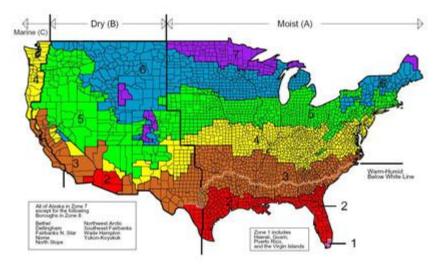


Figure 1: Climate Zones for the United Stated locations

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 Resident	ial ASHRAE 90.1	Non Reside	ntial 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	F730	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 ft². 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	1 in.
2 1/2 in. and larger	1 1/2 in.
Lower Pressure Steam and Condensate Return: 2 in. and smaller	1 1/2 in.
2 1/2 in. and larger	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 Co	ompliance		
Fan No.	HP	CFM	CFM*0.0015 (Variable Volume)	Compliance ?
MAU-1	2@71/2	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/ft². 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
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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. <u>Architectural Construction Documents</u>. HGA Architects and Engineers, Minneapolis, MN.

HGA Architects and Engineer. <u>Electrical Construction Documents</u>. HGA Architects and Engineers, Minneapolis, MN.

HGA Architects and Engineer. <u>Mechanical Construction Documents</u>. HGA Architects and Engineers, Minneapolis, MN.

Appendix A – Ventilation Rate Procedure

Building: System Tag/Name: Operating Condition Decoription: Units (celled from pull-down list)	The Ar MAU - Design IP	The American Swedich inctitute MAU - 1 and heat pump systems Design Peak Cooling Load Cond IP	The American Swedich Inctitute MAU - 1 and heat pump systems Design Peak Cooling Load Condition IP							
Inpute for System Floor area served by system Population of area served by system (including diversity) Design primary supply fan ainflow rate OA requires for system (Weighted average) OA require person for system area (Weighted average) Inpute for Potentially Critical zone	Name Ps Ras Ras	Units st cfm cfm/st cfm/s	100% diversity	3ystem 34725 908 48,880 0.09 5.8						
					Electrical/Tele com	Mechanical	Elev Equip Room	Quarantine & Table/Chair,	Building Engineer	Elev Equip Room
Zone Name								storage and Corridor		
Zone Tag	Zone t	ate avra jungie i	Zone tite turns purple fails for critical zone(s)		0A-1	0A-2	0A-3	0A-4	0A-5	0.A-8
Space type					equipment	Corridore	Elevator	roome	Office space	Elevator
Floor Area of zone	Å	Select from pull-down list	JI-down list		rooms 400	8	rooms	320	150	rooms
Design population of zone	N	P (defa	(default value listed; may be ovemidden)	erridden)	_			0	0.75	0
Design total supply to zone (primary plus local recirculated) Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	Vdzd	cfm Select from pu	cfm Belect from pull-down list or leave blank if N/A	INA	1,000	300	630	630	300	1000
Inputs for Operating Condition Analyzed	9							0		
Percent of total design airflow rate at conditioned analyzed	0		Lucious list	100%	%001	100%	100%	100%	100%	100%
Zone air distribution effectiveness at conditioned analyzed	2				1.00	1.00	1.00	1.00	1.00	1.00
Prinnary air maction or supply air at conditioned analyzed Recults	g									
Outdoor ain intake required for system	<pre>5</pre>	Î		10427						
Outdoor air per unit floor area	VotiAs			0.30						
Outdoor air per person served by system (including diversity) Outdoor air as a % of design primary supply air	Ypd Yours	ch chi		12.8 21%						
Detailed Calculations Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vips		VpdDs							
Uncorrected OA regid as a fraction of primary SA	Xs Vou		Vou / Vps	· 0.16						
Initial Caloulations for Individual zones	1				1		;		1	
OA rate per unit area for zone OA rate per person		climite			00.0	0.00	000	0.00	5.00	0.00
Total supply air to zone (at condition being analyzed)					1000	300	630	630	300	1000
Unused OA regid to breathing zone		••	Ripz Pz + Raz Az ViherFez	••	24.0	33.9	۶ 60	38,4	12.8	12.0
Fraction of zone supply not directly recirc. from zone	7	•	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 Fraction of zone CA not directly recirc from zone	7 7		Ep 1-(1-Pz)/1-En)/1-En	•	1	1.00		1.00	1 is	1.00
Unused OA fraction required in supply air to zone	2		Voz/Vdz	•	0.02	0.11	0.01	0.06	0.04	0.01
	²²		Voz./ Vpz	•	0.02	0.11	0.01	0.06	0.04	0.01
Zystem Ventilation Efficiency (App A Method) 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) Minimum outdoor air Intake airflow	P		Value from Table 6.3	- 0.73						
Outdoor Air Intake Flow required to System	Vot	ch •	Vou / Ev	- 10427						
			Vot / Vps	- 0.21						
Outdoor Air Intake Flow required to System (Table 6.3 Method) OA Intake realities a traction of primary SA (Table 6.3 Method)	< vot	en H	Vou / Ev	- 10548						
OA Temp at which Min OA provides all ocoling	1		a contra a para							
				•						

Building: System TapName: Operating Condition description: Units (select from pull-down list)	The A MAU - Decign IP	The American Swedich Inctitude MAU - 1 and heat pump systems Design Peak Cooling Load Condition IP						
item of by system (including diversity) or system (Weighted average) system area (Weighted average) ee	Name As Ps Vpsd Ras Rps	Unite p 100% diversity cm cm/st	3yctem 34725 48,880 0.19 5.8					
Zone Name			Storage, Maint Storage, & Maint Shop	Collection Storage	Corridor, Work & Material Storage	Retall Work Storage	Classroom	Gust Exterior Offices
Zone Tag	Zone t	Zone the turns purple fails for critical zone(s)	0A-7 Storage	0A-8 Storage	0A-9 Office space	0A-10 Storage		1A-2 Office space
Space Ope		Select from pull-down list	rooms	roome		roome	olaseroom	
Floor Area of zone Design population of zone	2 2	sf P (default value listed: may be overridden)	685	2400	3,425	1020	780	1.175
Design total supply to zone (primary plus local recirculated) Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	Vdzd		1000	1200	1000	630	1000	400
Local recirc. air % representative of ave system return air	ц		15%	75%	15%	15%	75%	15%
Imputer on Operating Contration Among and Air distribution type at conditioned analyzed	Ds	% Select from puli-down list	100% 100%	100%	100%	100%	100%	100%
Primary air fraction of supply air at conditioned analyzed	9 B							1.00
Recuite	7							
Outdoor air intake required for system	Vot	cfm	10427					
Outdoor air pes unin noor area Outdoor air pes person served by system (including diversity) Outdoor air as a % of design primary supply air	VotiPs Ypd	chu)p chu	12.9 21%					
Detailed Calculations Initial Calculations for the System as a whole								
Primary supply air flow to system at conditioned analyzed	Vps	VpdDs	48880					
UncorrectedUA requirement for system Uncorrected OA regid as a fraction of primary SA	Xs	 Hps Ps + Has As Vou / Vps 	0.16					
Initial Calculations for Individual zones OA rate per unit area for zone	Raz	cfm/sf	0.13	0.12	0.05	0.12	0.05	0.06
OA rate per person Total supply air to zone (at condition being analyzed)	V dz	chu (1000		1000	630	1000	400
Unused OA regid to breathing zone		 Rpz Pz + Raz Az Vibulet 	. 8	N	58 2	122.4	196.8	20.0
Fraction of zone supply not directly redire. from zone	7	- Ep+(1-Ep)Er -	1.00		1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly rectire, from zone	7 7	- Ep - 1-/1-Ex//1-En//1-En/	1.00	1.00	1 is	1.8	18	1.00
Unused OA fraction required in supply air to zone	2		0.1		0.06	0.19	0.20	0.05
Unused OA fraction required in primary air to zone	5		0.08		0.06	0.19	0.20	0.05
System Ventilation Efficiency (Ann & Mathod)	5	- (En + EhXe - ErZi)/En	10		÷	790	2	*
System Ventilation Efficiency (App A Method)		 min (Evz) 				0.90		
Ventilation System Efficiency (Table 6.3 Method)	P !	n Table 6.3 -	0.73					
Minimum outdoor air Intake airflow Outdoor Air Intake Flow required to System	√ot	•	10427					
	۲	 Vot / Vps 	0.21					
Outdoor Air Intake Flow required to System (Table 6.3 Method) OA Intake red/d as a fraction of orimary SA (Table 6.3 Method)	× ×	cfm - Vou/Ev - 1	10548					
OA Temp at which Min OA provides all cooling			,					
anterna 🕄 en anterna de la contra anterna de la contra de		and the second the statement of the second s	•					

mmmm () si won overna voi nom wood i voi	OA Temp at which Min OA provides all cooling	OA Intake regid as a fraction of primary SA (Table 6.3 Method)	Outdoor Air Intake Flow required to System (Table 6.3 Method)	ON intest regions a fraction of primary an		Cutdoor bit intere diministration of the Contern	frequencies of story of Automatics Interesting and	Manuficture Contained Contained (Table C 2 Manual)	Contain Mantington Efficiency (Ann. 4 Matter)	Zone Ventilation Efficiency (App A Method)	Suctan Vanilation Efficiency	Unused OA fraction required in primary air to zone	Unused OA fraction required in supply air to zone	Fraction of zone OA not directly recirc, from zone	Fraction of zone supply from fully mixed primary air	Fraction of zone supply not directly redire, from zone	Unused UN requirement for zone	and function of ball you backing	I want supply set to bound (at contained oning unarganes)	Tabal supply as in the same lat something balance analysis.	OA rate per person	OA rate per unit area for zone	Initial Calculations for Individual zones	Uncorrected OA regid as a fraction of primary SA	UncorrectedOA requirement for system	2	Initial Calculations for the System as a whole	Defelled Oxfordsform	Outdoor air as a % of design primary supply air	Outdoor air per person served by system (including diversity)	Outdoor air per unit floor area	Outdoor air Intake required for system	Ventilation System Efficiency	Reculta	Primary air fraction of supply air at conditioned analyzed	Zone air distribution effectiveness at conditioned analyzed	Air distribution type at conditioned analyzed	Percent of total design almow rate at conditioned analyzed	Inputs for Operating Condition Analyzed	Local recirc, air % representative of ave system return air	Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	Design total supply to zone (primary plus local recirculated)	Design population of zone	Floor Area of zone		Space type		Zone Tag		Zome Name	Wantan Kianaa		Inpute for Potentially Critical zones	OA regid per person for system area (Weighted average)	OA regid per unit area for system (Weighted average)	Design primary supply fan almow rate	Population of area served by system (including diversity)	Floor area served by system	Inpute for System	opventin opvinime. Operating Condition Decoription: Units (celect from pull-down list)	Building:	
I		۲	Vot	1	1	ž	1	2	2	5	1	N _D	Zd	7	7	Fig.	VOZ	VUL	Ĩ	Ì		Raz		č		Vps		L	Yр	VotiPs	VotiAs	Vot	V		e.	,		g		Ψ		Vdzd	R	Å					ľ					Rps	Ras	Vpsd	P	3	Name	Decig	The A	
n dan					5	ł											9		}	ł		chin)st			9	9						1					Select	\$			Select	8	U	1	Select									cfinip	chinist	1			Unite	n Peak C	merioan	
		•	•	•	•				•	•		•	•	•	•	•	•	•						•	•	•		L									from p				from p		(deta		from p													_		Sooling	Swedi	
 UID-012/11-11/02004 		Vot / Vps -	Vou / Ev -	- Activity	YOU / EY		VERSE HOLD FRANK WAS	Vision from Table 5 2		(Fa + FbXs - FcZ) / Fa		Vinz / Vinz		1-(1-Ez)(1-Ep)(1-Er)	۳	Ep + (1-Ep)Er -	VODEZ		Door De L Dan La						Rps Ps + Ras As -	VpdDs -											Select from puli-down list				Select from pull-down list or leave blank if N/A		(default value listed; may be overridden)		Select from puli-down list			And sources and sources and the	Zona Mia turne numia Ballo for otheral monate)								100% diversity			meo - i and near pump systems Design Peak Cooling Load Condition IP	The American Swedish Institute	
		0.22	1054	12.0	12401																			0.16	7747	48880			21%	12.8	0.30	10427	0.74					109			NIX.		idden)											'n	60'0	48,880	8	3472	System			
å	•	N	^{oo}			4				1 10	1	20.0	80.0	1.00	1.00	1.00	16				8	0.05		m	7	•			*			-	-			1.00	8	100%		75%		630	2.2	440			Office space	1A-3			erence/Recep tion/Printer	Walting/Conf		00	w	0		in	-		1	
										1 13		60.0	0.03	1.00	1.00	1.00	K	10		4200	0.00	0.06														1.00	8	100%		75%		1600		860			Corridore	1A-4				Hallways										
									-	1 07	-	90.0	60.0	1.00	1.00	1.00	8					0.06														1.00	60	100%		75%		630		920			Corridore	1A-5			Restrooms	Hallways,										
										1.01			0.15	1.00	1.00	1.00	9	0.00			500	0.06														1.00	8	100%		75%		400	3.575	715			ŝ	1A-8			Purpose, Hallway	Multi-										
										1.10		200	0.06	1.00	1.00	1.00	b		1		8	0.05														1.00	00	100%		75%		400	1,475	295			00	1A-7		Receiving	Support, Shipping &	Catering										
										0 95		0.24	0.21	1.00	1.00	1.00	225		L COL		7 50	0.18														1.00	8	100%		75%		1400	12	1130		food dining	Cateteria/fact-	1A-8			Storage	Kitohen,										

Building: 3ystem TauName: Operating Condition Decoription: Unite (celect from pull-down liet)	The A MAU - Desig IP	merioan 3w -1 and heat n Peak Coo	The American Swedich institute MAU - 1 and heat pump systems Design Peak Cooling Load Condition IP							
Inputs for System Floor area served by system Population of area served by system (including diversity) Design primary supply fan ainflow rate OA regid per unit area for system (Weighted average) OA regid per unit area for system area (Weighted average)	Name As Ps Vpsd Ras	unite sf cfm cfm/sf	100% diversity	3ystem 34725 908 49,880 0.09 5.8						
inputs for Potentially Critical zones					Café Room	Conference	Gallery	Reception, Storage,	Gift Shop	Lobby
Zone Name								Office		
Zone Tag Soace hoe	Zone	tite turns pu	Zone the turns purple fails for critical zone(s)		1A-8 Cafeteria/tast- (1A-10 Conferenceim	1A-11 Mucoumcigall	1A-12 Office space	1A-13 Salec (except	1A-14 Lobbiec
	A.,	Select fro	Select from puli-down list		1700	1000	1075	net	200	
Design population of zone	2 2		(default value listed; may be overridden)	midden)	70	25	15	1.95	12.75	94.5
Design total supply to zone (primary plus local recirculated) Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	Vdzd	cfm Select fro	cfm Select from pull-down list or leave blank if N/A	INA	2000	2000	1400	400	2000	1400
Local recirc, air % representative of ave system return air	Ψ				75%	75%	75%	75%	75%	75%
Inputs for Operating Condition Analyzed Percent of total design airflow rate at conditioned analyzed	B	*	*	100%	100%	100%	100%	100%	100%	100%
Zone air distribution effectiveness at conditioned analyzed	7				1.00	1.00	1.00	1.00	1.00	1.00
Recute	1									
Outdoor air intake required for system	√ot			10427						
Outdoor air per person served by system (including diversity)	VotiPs	c dim/p		12.9						
	1									
Detailed Calculations Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vps	} 9								
Uncorrected OA regid as a fraction of primary SA	Xs	1	 Nou / 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				7.50	5.00	7.50	5.00	7.50	5.00
Unused OA regid to breathing zone		8	 Rpz Pz + Raz Az 	•	831.0	185.0	177.0	33.2	197.6	510.3
Unused OA requirement for zone Eraction of zone supply not directly regins, from zone		8		•••	1 00	1 85	1 1 1 1 1		1 198	1 00
Fraction of zone supply from fully mixed primary air	7			•	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to some	27		 1-(1-Ez)(1-Ep)(1-Er) Viot / Viot 	•••	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in primary air to zone	91			•	042	0.09	0.13	0.08	0.10	96.0
System Ventilation Effolency					1		i	;	ł	
Zone Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method)			 (F3 + F0X5 - FCZ) / F3 min (Evz) 	- 0.74	0.74	1.07	1.03	1.08	1.06	0.79
Ventilation System Efficiency (Table 6.3 Method)	۳ ! ۲		 Value from Table 6.3 	-						
	Vot	}			•					
OA intake regid as a fraction of primary SA	۲			• 0.21						
Outdoor Air Intake Flow required to System (Table 6.3 Method)	(≤	ł	- Vou / Ev	- 10548						
OA Temp at which Min OA provides all cooling	1		- voir spe							
OAT below which OA intake flow is @ minimum		Deg F	 (Tp-dTsf)-(1-Y)/(Tr+dTn 	•						

OAT below which OA intake flow is (3) minimum	OA Temp at which Min OA provides all occiling	Outdoor wir inteke How required to system (Lable 5.3 Method)	OA intexe regio as a traction of primary SA	Outdoor Air Intake Flow required to System	Minimum outdoor air intake airflow	Ventilation System Efficiency (Table 6.3 Method)	System Ventilation Efficiency (App A Method)	Zone Ventilation Efficiency (App A Method)	System Ventilation Efficiency	Unused UN traction required in primary air to zone	oursed on literation reduced in adding our to some	mechanical disease on not include include internet	Encoder of some OA and directly more long to an and	Constitute of some supply from fully solved activate at	Fraction of zone supply not directly redire, from zone	Unused OA requirement for zone	Unused OA regid to breathing zone	Total supply air to zone (at condition being analyzed)	OA rate per person	O/A rate per unit area for zone	Initial Calquiations for individual zones	Vie Alevand to Horsen e ee e has von particular		mining supply an new to system at conditioned analyzed	Initial Calculations for the System as a whole	Detailed Calouiations	Outdoor air as a % of design primary supply air	Outdoor air per person served by system (including diversity)	Outdoor air per unit floor area	Outdoor air intake required for system		Reculta	Primary air fraction of supply air at conditioned analyzed	Zone air distribution effectiveness at conditioned analyzed	Air distribution type at conditioned analyzed	Percent of total design airflow rate at conditioned analyzed	Ana	Local recirc, air % representative of ave system return air	Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	Design total supply to zone (primary plus local recirculated)	Design population of zone	Floor Area of zone		Space type		Zone Two		Zone Name			Inputs for Potentially Critical zones	OA regid per person for system area (Weighted average)	OA regid per unit area for system (Weighted average)	Design primary supply fan alrifow rate	Provide the offerse second by system (including dimensio)	Inputs for System		Units (select from pull-down list)	System Tag/Name: Constitue Condition Departmine:	Building:	
	ľ	Y OT	1	VOT		Ev	P	EVZ		\$	1 6	17	7 2	9 ;	1	Voz	Vbz		Rpz	NDZ		5	NOT	C C C	ĺ		Тр	VotiPs	VotiAs	Vot	V		ų	ų		G		Ψ		Vdad	N	à				-	1					Rps	Ras		2	Name		P	MAU -	The A	
Deg F - {(T		- vo		- V0		- 12	• •	- (F		- V0	• •			, ,	•	•	chini - Ro	8	cfm/p	CINVST			- N				đ			1					Select from pull-down list	8			Select from pull-	đ	P (default		Select from pull-			and surfaced entries and						cfm/p	cfm/sf	۲ (Unite	_ I	IP	MAU - 1 and heat pump systems Design Peak Cooling Load Cond	The American Swedich Institute	
{(Tp-dTsf)-(1-Y)*(Tr+dTrt =	and a loss	VOU / EV	Vot / vps	Vou / EV	i	Value from Table 6.3	min (Evz)	(Fa + FbXs - FcZ) / Fa		VOZ/ VDZ	AOX / AOX	In the second second second			EDIEr	Vbalez	Rpz Pz + Raz Az					eda uno a	Lev ceru												down list				Select from pull-down list or leave blank if N/A		(default value listed; may be overridden)		down list			source and manual building water but character source(a)	the fibers resultion of monormal in i							Are not a second	100% diversity				systems and Condition	Institute	
		, is	- 0.21	10427		- 0.73	0.74	•						'	•	•	'										21%	12	0.30	10427	0.74					100%			NIA		ridden)											un	2	48,880		System	Ī				
÷	;	58				u	•	0.79		650				ŝ		510	510.3	1400	5.00	80.0		ō		1 6	5		*		•	7	•			1.00	6	% 100%		75%		1400	94.5	630			Lobbles	14.16				Lobby	ritioal Zones	œ	9]				
								1.07		en n	0.03				1.00	55	55.2	630	0.00	0.05														1.00	8	100%		75%		630	0	920			Corridore	24-1			Storage, Rectrooms	Coat,											
								601		7010				ŝ		8	27.6	400	0.00	80.0														100	8	100%		75%		400		460			ä	24.2				Hallways											
								0.93		0.23				8	1.00	365	364.8	1600	7.50	0.06														1.00	8	100%		75%		1600	38,4	1280		notion	Lobbles/prefu	24.3				Prefunction											
								1610		5				ŝ		5	501.8	2000	5.00	80.0														1.00	S	100%		75%		2000	85	1280		accombly	60	24.4			3paoe	ă.											
								0.91		0.25	24.0	1.00	-		1.00	503	503.0	2000	5.00	0.06														1.00	8	100%		75%		2000	85	1300		accembly	Multipurpose	24.6			Space	Center Event											

Building: System TagName: Operating Condition Decoription: Units (celect from pull-down list) Units for System Floor area served by system	The Am MAU - 1 Decign IP IP	Peak Co	at pur	The American Swedich Inetitule MAU - 1 and heat pump systems Design Peak Cooling Load Condition IP IP		System 34725						
Inputs for System Floor area served by system (including diversity) Design primary supply fan airflow rate OA reqd per unit area for system (Weighted average) OA reqd per primarea for system area (Weighted average) Inputs for Potentially Critical zones	Name Ps Ras Rps	cfm)p	_	100% diversity		3yctem 34725 808 48,880 0.09 5.8	South Event	Kittohen			Classroom,	Classroom,
Zone Name							South Event Space	Kitohen	Kifohen, Hallway	Hallway. Community	Classroom, Hallway	Classroom, Hallway
Zone Tag Space type	Zone th	le turns p	urple .	Zone the turns purple fails for critical zone(s)			2A-8 Multipurpose C	2A-7 2A-8 Cateteria/tast- food dinina food dinina	2A-8 Cafeteria/tact-	0T-1 Authpurpose	0T-2 Leoture	0T-3 Lecture
olane Ola		Select f	om pr	Select from pull-down list				Duru Doot	tood dining	accomply	oraceroom	0135670.000
Floor Area or zone Design population of zone	2 2	פיס	(defa)	(default value listed; may be overridden)	e overni	dden)	1310	515	400	820 45	520	25
Design total supply to zone (primary plus local recirculated) Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	Vdzd	Crim Select 1	om pr	cfm Select from pull-down list or leave blank if N/A	lank II t	\$	2000	1000	1000	1200	1000	1000
Local recirc, air % representative of ave system return air Inputs for Operating Condition Analyzed	ц						15%	15%	15	100	75%	
Percent of total design airflow rate at conditioned analyzed Air distribution time at conditioned analyzed	0	2 g		95 Stalaet from pull-down list	_	100%	100%	100%	100%	100%	100%	10%
Zone air distribution effectiveness at conditioned analyzed Deimany air fraction of auroby air as poortitioned analyzed	9 W						1.00	1.00	1.00	1.00	1.00	1.00
						0.74						
Outdoor air intake required for system	Vot	9				10427						
Outdoor all per unit and and by system (including diversity) Outdoor all as a % of design primary supply air	Vot/Ps					12.9 21%						
Detailed Calculations Initial Calculations for the System as a whole												
Primary supply air flow to system at conditioned analyzed UncorrectedOA requirement for system	Vps	<u>}</u>	••	VpdDs Rps Ps + Ras As		48880 7747						
Initial Calculations for Individual zones	8		•	You / Vps		0.16	1	;	;			
OA rate per unit area tor zone OA rate per person	Rpz	dim/p					5.00	7.50	7.50	5.00	7.50	7.50
Total supply air to zone (at condition being analyzed) Unused OA reofd to breathing zone		<u>}</u>	•	Roz Pz + Raz Az			2000	1000	1000	1200	218.7	1000
Unused OA requirement for zone	Voz	₿ I	•	VloziEz			123	123	នី	274	219	226
Fraction of zone supply from fully mixed primary air	33		• •	Ep Charlen			10	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	27			1-(1-Ez)(1-Ep)(1-Er)			1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in primary air to zone	81		•	Voz / Vpz			81	0.12	0.10	0.23	0.22	0.23
System Ventilation Efficiency	1						ź	2	Ŕ	0	2	2
System Ventilation Efficiency (App A Method)	7		• •	min (Evz)		0.74	ŝ	5			5	
Ventilation System Efficiency (Table 6.3 Method)	Δ.		• •	Value from Table 6.3		0.73						
Minimum outdoor air Intake airflow Outdoor Air Intake Flow required to System	Vot	3	•	Vou / Ev		10427						
	Y		•	Vot / Vps		0.21						
Outdoor Air intake Flow required to System (Table 6.3 Method) OA intake reald as a fraction of ortmany SA (Table 6.3 Method)	¥ vot	8		Vot / Vot		10548						
					2							
and a second				The second s								

Building: System Tap/Name: Operating Condition Decomption: Units (select from pull-down list) Inputs for System Polor area served by system (including diversity) Polor area served by system (including diversity) Design primary supply the airflow rate OA read per unit area for system (Weighted average) OA read per unit area (Weighted average) OA read per unit area (Weighted average) OA read per unit area (Weighted average)	The An MAU - Decign Decign P P P P P P P P P P P P P P P P P R P S Rps	The American Swedish Incitiute MAU - 1 and heat pump systems Design Peak Cooling Load Condition P As si Ps P Vipsd chm Ras chm/st Rps chm/st	3yctem 34725 49,880 5,8	Haliway,	Kitchen	Volunteer	Hallways,	Elev Equip	Links
Zone Tag Space type	Zone ti	Zone the turns purple fails for critical zone(s)		0T-4 Multipurpose C	0T-5 Caleteria/fact- (food dining	0T-8 Conferenceim eeting	0T-7 Corridore	0T-8 Elevator maohine	0T-9 Corridore
Floor Area of zone	2			18	200	770	1300	rooms 100	
Design population of zone Design total supply to zone (primary plus local recirculated) Induction Tensional Unit: Dual Fan Dual Duct or Transfer Fan?	Vdzd	P (default value listed; may be overridden) cfm Select from oull-down list or leave blank if N/A	erridden)	1200	400	800	1000	0 1200	
Local recirc, air % representative of ave system return air	щ			75%	75%	75%	75%	75%	
Inputs for Operating Condition Analyzed Percent of total design airflow rate at conditioned analyzed Air distribution type at conditioned analyzed Zone air distribution effectiveness at conditioned analyzed Primary air fraction of supply air at conditioned analyzed	8 8 8	% Select from puli-down list	100%	100% CS	100% C3	100% 1.00	1.00%	100% CS	
ersity)	Ev Vot VotiAs VotiPs Ypd	chm chm)aí chm)a	0.74 10427 12.9 12.9 21%						
Detailed Calculations Initial Calculations for the System as a whole Initial Calculations for the System at conditioned analyzed UncorrectedOA requirement for system	Vou ∨ps	cfm = VpdDs cfm = Ros Ps + Ros As	- 48880 7747						
rd as a fraction of primary SA dual zones la for zone	Ks	द्ध ।		0.06	0.18	0.06	0.06	0.12	
ion being analyzed) ie		•	•	5,00 1200 274.2	7.50 66.0	96.2	1000 78.0	1200	
Unused OA requirement for zone Fraction of zone supply not directly redire. from zone		cfm - Vbz/Ez - Ep + (1-Ep)Er	•••	1.00	1.00 66	វិទីរ	1.00	10 1	
Fraction of zone supply from ruly mixed primary an Fraction of zone OA not directly rectire, from zone	78	 Ep 1-(1-Ez)(1-Ep)(1-Er) 	•••	1.00	1.00	1.00	1.00	1.00	
Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone	68	 Voz / Vdz Voz / Vbz 	• •		0.17	0.12	0.08		
System Ventilation Efficiency	÷	and a pana	ľ						
Zone Ventilation Efficiency (App A Method)		 (Fa + FbXs - FcZ) / Fa 		0.93	0.99	1.04	1.08	1.15	
Vendiation System Efficiency (Table 6.3 Method)	1	 Value from Table 6.3 	0.73						
Minlimum outdoor air Intake airflow Outdoor Air Intake Flow required to System	Vot	cfm - Vou / Ev	- 10427						
OA Intake regid as a fraction of primary SA Outdoor Air leases From regularity to Susteen (Table 5.3 Method)	4	- Vot / Vips	- 0.21						
SA (Table 6.3 Method)	1								
OA temp at which min we provides all occuring OAT below which OA intake flow is (2) minimum		Deg F = {(Tp-dTst)-(1-Y)/(Tr+dTr)	•						

Building: Bysiem Taginame: Operating Condition Decoription: Unite (celect from pull-down liet)	The A MAU - Decig	merioan 3 -1 and hea n Peak Co	The American Swedich Institute MAU - 1 and heat pump systems Design Peak Cooling Load Condition IP							
Inpute for System Floor area served by system Population of area served by system (including diversity) Design primary supply fan altriow rate OA redd per unit area for system (Weighted average) OA redd per person for system area (Weighted average) Inpute for Potentially Orthoal zones	Name As Ps Vpsd Ras Rps	chulte chulte chulte	100% diversity	3ystem 34725 908 49,890 0,09 5,8	8 9 9 9 9 15 1					
Zone Name					Links	Archive, Storage	Gallery	Library	storage	Work Room
Zone Tag	Zone	itte turns ju	Zone the turns purple fails for critical zone(s)	(2)	0T-10 Corridore	0T-11 Storage	0T-12 Muceumolgall	0T-13 Libraries	0T-14 Storage	1T-1 Storage
Space type		Select fr	Select from puli-down list				eries		roome	roome
Floor Area of zone Design population of zone	2 2	ъ щ	(default value listed; may be overridden)	be overridden)	320	1190	1100	500	280	280
Design total supply to zone (primary plus local recirculated) induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	Vdzd	cfm Select fr	cfm Select from pull-down list or leave blank if N/A	blank if N/A	800	800	1400	300	400	1000
Inputs for Operating Condition Analyzed		•								
Air distribution type at conditioned analyzed Zone air distribution effectiveness at conditioned analyzed	N I	Select fr	Select from puli-down list		1.00	1.00	1.00	1.8 6	1.00	1.8
Primary air machon or suppry air at conditioned analyzed	ų									
Outdoor air Intake required for system	√ot			10427	1 .					
Outdoor air per person served by system (including diversity) Outdoor air as a % of design primary supply air	VotiPs Ypd	ង ឆ្ន		12.9	¥					
Detailed Caloulations Initial Caloulations for the System as a whole										
Primary supply air flow to system at conditioned analyzed UncorrectedOA requirement for system	V V V	₿ ₿	 VpdDs Rps Ps + Ras As 	- 48880 - 7747	58					
Initial Calculations for individual zones OA rate per unit area for zone	Raz	chm/sf				0.12	0.06	0.12	0.12	0.12
O.A rate per person Total supply air to zone (at condition being analyzed)		th th			800	800	7.50	5.00 300	400	1000
Unused OA regid to breathing zone		19	- Roz Pz + Raz Az	•	19.2	142.8	39610	85.0	316	33.6
Fraction of zone supply not directly redire, from zone	Fa	1	 Ep + (1-Ep)Er 	•••	1.00	1.00	1.00	1.00	i si	1.00
Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone	7 7		 Ep 1-(1-Ex)(1-En)(1-En) 		100	1.00	1 10	1.00		1.00
Unused OA fraction required in supply air to zone	N		 Voz / Vdz 		0.02	0.18	0.28	0.28	0.08	0.03
System Ventilation Efficiency	\$		 VOZ / VDZ 	•	2010	0.18	87.0	0.28	uus	0.03
Zone Ventilation Efficiency (App A Method)	? <u>-</u>		 (Fa + FbXs - FcZ) / Fa 	••	1.13	0.98	0.88	0.88	1.07	1.12
Ventilation System Efficiency (Table 5.3 Method)	2		 Value from Table 5.3 	- 0.73	ωı					
Minimum outdoor air Intake airflow Outdoor Air Intake Flow required to System	Vot	<u>a</u>	 Vou / Ev 	- 10427	27					
OA intake regid as a fraction of primary SA		ł	 Vot / Vips 	- 0.21	. 1					
OA intake regid as a fraction of primary SA (Table 6.3 Method)	*	1	- Vot / Vps	•	13.1					
OAT below which OA intake flow is (g) minimum		Deg F	 {(Tp-dTsf)-(1-Y)*(Tr+dTr 	•	Ġ					

					((Tp-dTs()-(1-Y)/(Tr+dTr)	• •	Deg F		OA Temp at whitement of a same uncountry on the same same same of OAT below which OA intake flow is @ minimum
					Viola J Vine		8	1	Outdoor out invate new required to system (rights 5.3 Method) OA intake regist as a fraction of others (SA (Table 5.3 Method))
					Vot / Vps		ł		On insist regions a inscription of primary and
			10427	•	Vou / EV	•	Cim		Outdoor Air Indake Flow required to System
						e	ł		Minimum outdoor air Intake airflow
			0.73		Value from Table 6.3	•		Ev	Ventilation System Efficiency (Table 6.3 Method)
			0.74		min (Evz)	•		V	System Ventilation Efficiency (App A Method)
				•	(Fa + FbXs - FcZ) / Fa	•		Evz	Zone Ventilation Efficiency (App A Method)
									System Ventilation Efficiency
	6	0.42 Maximum Zp			Voz./ Vpz			ų	Unused OA fraction required in primary air to zone
	a	0.42 Maximum Z			Voz / Vdz			Zd	Unused OA fraction required in supply air to zone
					1-(1-Ez)(1-Ep)(1-Er)	•		7	Fraction of zone OA not directly recirc, from zone
				•	U	•		7	Fraction of zone supply from fully mixed primary air
					Ep + (1-Ep)Er	•		F.	Fraction of zone supply not directly recirc, from zone
		7747			Vbalez		ł	Voz	Unused OA requirement for zone
		7747			Rpz Pz + Raz Az	•	8	Vbz	Unused OA regid to breathing zone
		48880					8		Total supply air to zone (at condition being analyzed)
							ctimp	Rpz	OA rate per person
							cfm/sf	Raz	
									Initial Calculations for Individual zones
			0.16		Vou / Vps	•		Ğ	Uncorrected OA regid as a fraction of primary SA
sity. D	vulation diven	1.00 System population diversity. D	7747		Ros Ps + Ras As	•••	9 9		UncorrectedOA requirement for system
			40000			-	ł	Ĩ	Detailed Calculations Initial Calculations for the System as a whole
			21%				3	ž	Outdoor air as a % of design primary supply air
			12.9					VotiPs	Outdoor air per person served by system (including diversity)
			0.30				chinist	VotiAs	Outdoor air per unit floor area
			10427				3	Vot	Outdoor air intake required for system
			0.74					W	
								ł	Recults
49990 cfm	4998	1 DD average						5	Primary air fraction of supply air at conditioned analyzed
out rais to some					oelect from pull-bown list	nom pu	00000	7	Air distribution type as conditioned analyzed
		Server and a	100 10	г					The state of wood open at reading as a contraction of any act
			1002	-			R	2	Inputs for Operating Condition Analyzed
		1.00 average						Ψ	Local recirc, air % representative of ave system return air
			>	lank I'N	Select from pull-down list or leave blank if N/A	from pul	Select		Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?
		48880 total cfm					3	Vdzd	Design total supply to zone (primary plus local recirculated)
		807.7 total P	den)	e overrid	(default value listed; may be overridden)	(defau	U	PN	Design population of zone
		34725 total sf					4	Å	Floor Area of zone
					Select from pull-down list	from pul	Select		Space type
									Zone Tag
		Totals/averages	_	-	Zone the turns purple fails for critical zone(s)	purple It	the turns	Zone	
									Zone Name
		sitis ave crimp	5.8				dumb	Nps	OA regid per person for system areal (Weigned average) Inputs for Potentially Critical zones
		0.09 ave cfm/sf	0.09	_			clim/st	Ras	OA regid per unit area for system (Weighted average)
		1.41 clm/sf	48,880			г	9	Vpsd	Design primary supply fan airflow rate
		23.3 P/1000 sf	808	_	100% diversity			2	Population of area served by system (including diversity)
		Cheok Figures	34725	_				As Name	Floor area served by system
				,					
								P	Units (select from pull-down list)
					Design Peak Cooling Load Condition	ooling L	In Peak C	Decio	Operating Condition Decoription:
					MAU - 1 and heat pump systems	eat pum	-1 and h	MAU -	3 yetem Tag/Name:
					The American Swedich Institute	Swedici	merioan	The A	Building:

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
1 A- 1	Studio Classroom	First	780	400	197	Y
1A-2	Gust Exterior Offices	First	235	400	20	Y
1 A-3	Waiting/Conference/Reception/Print er	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
1 A- 8	Kitchen, Storage	First	1130	1400	293	Y
1 A-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

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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