The American Swedish Institute
Minneapolis, MN

Technical Report Two: Building and Plant Energy Analysis Report

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Executive Summary

The American Swedish Institute, scheduled to complete construction in late spring 2012, is a 24,600 square feet addition and 27,500 square feet 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 discusses and analyzes the results for a building load and energy simulation model of the American Swedish Institute performed in Trane TRACE 700. From the completed design load estimation load and ventilation, information was computed and compared to the design documents when available to verify the accurateness of the model and assumptions made. The annual energy consumption, operating costs, and emissions were also performed for the American Swedish Institute. The energy model could not be compared to the design engineer (HGA Architects and Engineers) since one was not completed at this time. Actual utility bills and data were not available for the American Swedish Institute. Therefore, all model information computed was compared to industry rules of thumb, the Department of Energy, and ASHRAE to verify the results with similar building types.

Although, the computed results could not be compared with the professional energy model all the results were compared to average values. Overall, the building model provided realistic results that could be refined further with more information about the schedules and occupancy for the building. The energy usage of the American Swedish Institute was compared to typical public assembly buildings and performed better than the average. This can be accounted for since the American Swedish Institute uses a more efficient geothermal system compared to the typical boiler system used in most museums. The geothermal system was broken down by individual components first, and then the components were complied into the overall system to give a utility cost breakdown.

To calculate the annual utility costs for all utilities, electrical and natural gas rates were taken from Xcel Energy in Minnesota. The overall utility cost for the American Swedish Institute is $2,545,853 annually. Total energy usage for electricity and natural gas is 2,914*10^6 Btu/Yr. This is equivalent to 2,843.3*10^6Btu/Yr for electricity and 71.2*10^6 Btu/Yr for natural gas.

Mechanical Overview

The American Swedish Institute contains a Make-up Air Unit that provides conditioned outside air to all occupied interior spaces for the addition and existing mansion. Heating and cooling needs for the building are provided by a geothermal source closed loop heat pump system shown in Figure 2.1 below. The system contains ninety-six well holes with a depth of 250 feet and approximately one ton capacity per hole. Heat pumps are used throughout the building and are served outdoor air from the Make-up Air Unit that is supplied from several VAV (Variable Air Volume) boxes throughout the building with the additional air being recirculated from the ceiling plenum by the return air from occupied spaces.

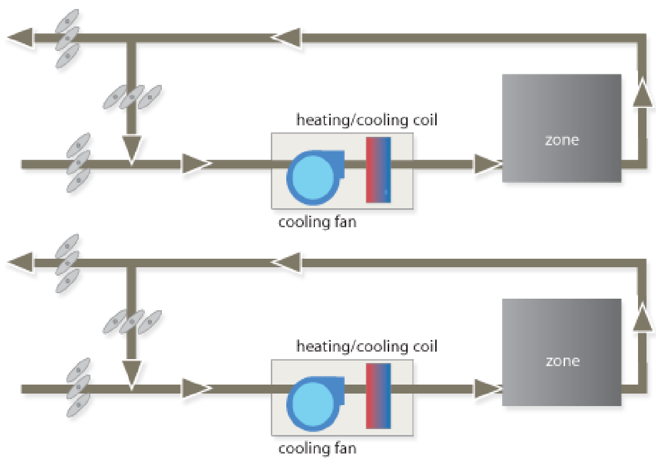

Figure 2.1: Heat Pump Schematic

Design Load Estimation

Modeling Information

Trane Trace 700 was used for the model created of the American Swedish Institute. The model was based off of the areas and ceiling heights used in the Architectural drawings. The information presented below was used throughout the model for the lighting and ventilation loads, and U coefficients were used when provided by the Mechanical engineer, otherwise rules of thumb and ASHRAE Standards were used to calculate and estimate the unknown information, shown below in Table 3.1.

Design Criteria		
Interior Load	Lighting	1.0 W/sq. ft.: Storage and Hallways 1.5 W/sq. ft.: Conference and High Occupancy rooms 2.0 W/sq. ft.: Retail
	Misc.	Estimated based on equipment in the room
Ventilation Load	All areas	Based on ASHRAE 62.1
People Density	Determined from Architectural Plans if available or based on ASHRAE 62.1	
U Coefficient	Typical U values provided from Trane TRACE 700 used	

Table 3.1: Design Criteria

Load Sources

The major sources of load in the American Swedish Institute are the occupants, electrical equipment, and lighting for both the existing mansion and addition. Solar gains are only a major source of load on the addition due to the large portions of glazing used on all sides of the building.

Design Occupancy and Ventilation

The ventilation rates used for each space were based on the recommended rates defined in ASHRAE. Occupancy for all the spaces were also based on ASHRAE Standard 62.1 values and were selected based on the closet match for space usage.

Infiltration

The American Swedish Institute addition was assumed to be pressurized with average construction. The existing mansion was assumed to be pressurized with poor construction since it is an existing building from the 1900s.

Electrical Loads

Lighting loads for the model are included above in Table 3. The miscellaneous loads used in the Trace model were estimated on the equipment shown in the design documents and ASHRAE values.

Weather Data

For the weather data used for the American Swedish Institute design temperatures were taken from ASHRAE Handbook of Fundamentals 2009 for Minneapolis, MN. Temperature values used were 99.6% and 0.4%. Outdoor air dry bulb temperature for the summer is 91°F and the outdoor air wet bulb temperature is 73.2°F. For the winter the outdoor dry bulb temperature is -14.9°F. This weather data information can be seen in Appendix A.

Schedules

All the templates for infiltration used schedules for infiltration and were assumed to be low rise office. Since an actual schedule was not provided by HGA Architects and Engineers, the hours of operation for the American Swedish Institute were taken off of the museum website. The American Swedish Institute is open Monday – Friday from 8:30 a.m. – 5 p.m. and 8:30 a.m. – 8 p.m. on Wednesdays. The museum is open Saturday and Sunday from 10 a.m. – 5 p.m. These hours were used to determine more accurate schedules then the one's provided in Trace. Shown in Tables 3.2 – 3.4 below is the approximated schedule and percentages based off the hours of operation. With actual schedules for the American Swedish Institute provided for the spaces increased accuracy for the model would be possible.

Cooling Design Weekday Schedule		
Start Time	**End Time**	**Percentage**
Midnight	5 a.m.	30
5 a.m.	6 a.m.	60
6 a.m.	7 a.m.	90
7 a.m.	8 p.m.	100
8 p.m.	9 p.m.	90
9 p.m.	10 p.m.	60
10 p.m.	Midnight	30

Table 3.2: Cooling Design Weekday Schedule

Heating Design Schedule		
Start Time	**End Time**	**Percentage**
Midnight	Midnight	100

Table 3.3: Heating Design Schedule

Saturday and Sunday Schedule		
Start Time	**End Time**	**Percentage**
Midnight	5 a.m.	30
5 a.m.	7 a.m.	60
7 a.m.	9 a.m.	90
9 a.m.	6 p.m.	100
6 p.m.	8 p.m.	90
8 p.m.	9 p.m.	60
9 p.m.	Midnight	30

Table 3.4: Saturday and Sunday Schedule

Design Load Results

There were seven systems considered for the American Swedish Institute all are water source heat pumps. Three of the systems were assigned to the addition and the other four systems were assigned to the existing mansion. Each system was analyzed to determine the % OA, cfm/ft^2, cfm/ton, ft^2/ton, and occupancy using Trane TRACE 700. These systems are shown in Tables 4.1 – 4.7.

Lower Level Addition Heat Pump		
	Cooling	Heating
% OA	7.7	7.7
cfm/ft²	0.50	0.50
cfm/ton	432.09	-
ft²/ton	870.07	-
Occupancy	18	-

Table 4.1: Heat Pump for Lower Level Addition

First Level Addition Heat Pump		
	Cooling	Heating
% OA	19.7	25.4
cfm/ft²	0.97	0.97
cfm/ton	299.31	-
ft²/ton	307.37	-
Occupancy	280	-

Table 4.2: Heat Pump for First Level Addition

Second Level Addition Heat Pump		
	Cooling	Heating
% OA	16.2	16.2
cfm/ft²	1.38	1.38
cfm/ton	341.10	-
ft²/ton	246.64	-
Occupancy	220	-

Table 4.3: Heat Pump for Second Level Addition

Lower Level Existing Heat Pump		
	Cooling	Heating
% OA	31.6	31.6
cfm/ft²	0.58	0.58
cfm/ton	259.03	-
ft²/ton	447.36	-
Occupancy	228	-

Table 4.4: Heat Pump for Lower Level Existing Mansion

First Level Existing Heat Pump		
	Cooling	Heating
% OA	11.7	11.7
cfm/ft^2	0.72	0.72
cfm/ton	377.71	-
ft^2/ton	521.21	-
Occupancy	34	-

Table 4.5: Heat Pump for First Level Existing Mansion

Second Level Existing Heat Pump		
	Cooling	Heating
% OA	7.4	7.4
cfm/ft^2	1.16	1.16
cfm/ton	412.40	-
ft^2/ton	357.05	-
Occupancy	29	

Table 4.6: Heat Pump for Second Level Existing Mansion

Third Level Existing Heat Pump		
	Cooling	Heating
% OA	12.4	12.4
cfm/ft^2	0.69	0.69
cfm/ton	372.95	-
ft^2/ton	543.37	-
Occupancy	22	-

Table 4.7: Heat Pump for Third Level Existing Mansion

The results for each space and zone can be seen in Appendix E. The % OA for the seven heat pump systems range from 7.4% - 31.6% seen from the tables above. The systems that seem high for outdoor air are the heat pumps in the lower level of the mansion and the first level of the addition shown in Tables 4.4 and 4.2, respectively. A possible reason for these higher values for % OA could be from the assumed schedules used in Trace. These would be adjusted with the actual schedules for the building but these areas would still be high with the proper schedule input. The reason for these areas having such a large % OA either way is the large occupancy rates in those areas of the building as well as, these heat pump systems serving a larger number of spaces compared to the other systems in the building. The other systems in the building have a reasonable amount of % OA for the use of the building although the actual schedule was not used in these spaces either.

A typical rule of thumb for a museum is between 250 – 350 ft^2/ton. This is for a typical museum space that doesn't have the same type of public spaces as the American Swedish Institute, which in general are composed of gallery, kitchen, office, and classroom spaces. When comparing this rule of thumb to the actual values calculated from the model it is shown that the ft^2/ton is much higher than the typical value. These values seem reasonable for the type of spaces that are being modeled since the American

Swedish Institute is not considered a typical museum building. Another reason for the higher ft^2/ton could also be from the assumption made about the schedules. These values are also high due to the large number of galleries and archives in the addition and existing building that are classified as critical spaces to preserve the artwork and furniture stored in those spaces as well as the work on display in the larger gallery spaces.

Further comparison of the individual heat pump systems ft^2/ton with each other gives accurate results especially for the spaces with the least amount of spaces storing art work. The heat pump for the lower level addition (Table 4.1) has the largest amount of ft^2/ton at 870.07 ft^2/ton, which is much larger than the other systems in the building. This heat pump system has the largest amount of archive and gallery storage spaces for the art work and furniture. Therefore, this system must supply more conditioned air to the spaces served by this system to keep moderate humidity and temperature levels so items do not get damaged. All the systems serving the mansion also have large ft^2/ton ranging from 357.05 – 543.37 ft^2/ton (Tables 4.4 – 4.7) since; these systems primarily serve gallery spaces and art work storage rooms the values seem reasonable. All of the systems with the large ft^2/ton would be more reasonable with the proper schedules for the spaces and the correct occupancy amounts but seem accurate for the type of use for the space.

Design Cooling		
Plant	**System**	**Main Coil (Tons)**
Cooling	A-Lower HP	7.9
	A-First HP	26.6
	A-Second HP	23
	T-Lower HP	18.7
	T-First HP	16.3
	T-Second HP	21.7
	T-Third HP	10.2
Total		124.4

Table 4.8: Peak Design Cooling Load

Design Heating		
Plant	**System**	**Main Coil (MBH)**
Heating	A-Lower HP	38
	A-First HP	195.4
	A-Second HP	148.8
	T-Lower HP	156.6
	T-First HP	282.4
	T-Second HP	339.7
	T-Third HP	174.8
Total		1335.7

Table 4.9: Peak Design Heating Load

All of the heat pump systems peak design heating and cooling loads occur in July; this is shown in Tables 4.8 and 4.9 above. Comparing the design heating peak loads in the existing building to the ones in the addition it is shown that the existing building's loads are much larger than the heating loads in the addition. This seems accurate due to the older construction of the mansion. The usage type of the spaces in the mansion being primarily gallery and archive spaces, particularly the first through the third levels also account for the higher heating loads in those areas. It can also be seen that the lower levels in both the mansion and addition are much smaller compared to the upper levels since, the lower levels are located below grade and do not lose a large amount of heating or cooling to the earth. The design heating loads are higher in the first and second level of the addition as well, due to the large portions of glazing on those two levels. The construction for these levels can be assumed to be average with some infiltration from the outdoors that yields increased heat loss during the winter months in Minnesota. Overall the loads would be more accurate with the actual occupancy for the conditioned spaces instead of using the predefined occupancy rates made by Trace that would then correct for any over estimations made by the software.

Energy Model Analysis

An energy analysis was performed on the American Swedish Institute to determine the annual energy consumption and operating costs of the mechanical plant for the building. The mechanical engineer on the project has not performed an energy analysis at this time, due to time being spent on other projects. There are no utility bills or data provided for the American Swedish Institute since it is currently under construction. Electric and gas rates were based off of the values provided by Xcel Energy for Minnesota. A value of $3.03/KW is used for the electric rate and is shown in Appendix B. The average rate of $0.62/Therm was used for natural gas over a year since the rates were split from April-October and November- March, these rates can also be seen in Appendix B.

The energy analysis also required the building schedule which was not provided by HGA Architects and Engineers. Due to this, the schedules were determined from the hours of operation provided on the American Swedish Institute website. These schedules are provided above in Tables 3.2 – 3.4. During the week the mechanical systems operate at 100% from 7 a.m. – 8 p.m. since the museum is open until 8 p.m. on Wednesdays therefore determining the schedule for the other days of the week.

After entering the schedules and energy rates into Trace an energy analysis was performed for the American Swedish Institute. The overall energy consumption annually for the building is shown in Table 5.1 below. Primary heating for the building is electric and natural gas since heat pumps are used for heating as well as, a boiler that is used for extra heating if the heat pumps need assistance for the colder days in Minnesota. All of the cooling for the American Swedish Institute is supplied by the various heat pump systems throughout the building that use electricity for cooling, where the cooling compressors use the majority of the energy for cooling. The fans for the heat pump systems used throughout the building also account for a large amount of electricity usage.

Energy Consumption Summary					
System		**Elec (KWH)**	**Gas (KBTU)**	**Total (KBTU/Yr)**	**% Total**
	Primary Heating	77,858	71,188	336,919	11.6
	Other	4,480	-	15,291	0.5
Primary Cooling	Cooling Compressor	118,538	-	404,569	13.9
	Other	132	-	451	0.0
Auxiliary	Supply Fans	122,891	-	419,428	14.4
Lighting	Lighting	490,330	-	1,673,496	57.4
Receptacle	Receptacles	18,843	-	64,310	2.2
Total		**833,072**	**71,188**	**2,914,464**	**100.0**

Table 5.1: Energy Consumption Summary

When looking at the total percentages for the American Swedish Institute's energy consumption per year, it is seen that heating, cooling, auxiliary, and lighting are the largest totals for energy consumption. To verify that the totals in Table 5.1 are correct, the American Swedish Institute's information was compared to typical public assembly's energy consumption provided by the Department of Energy. Shown in Figure 5.1 below is the typical distribution of energy in a public assembly building, which is similar to the usage of the addition and mansion. This figure shows that the heating load (44 %) accounts for the largest amount of energy usage in the building followed by cooling (15 %), lighting (10 %), and miscellaneous (9 %) loads.

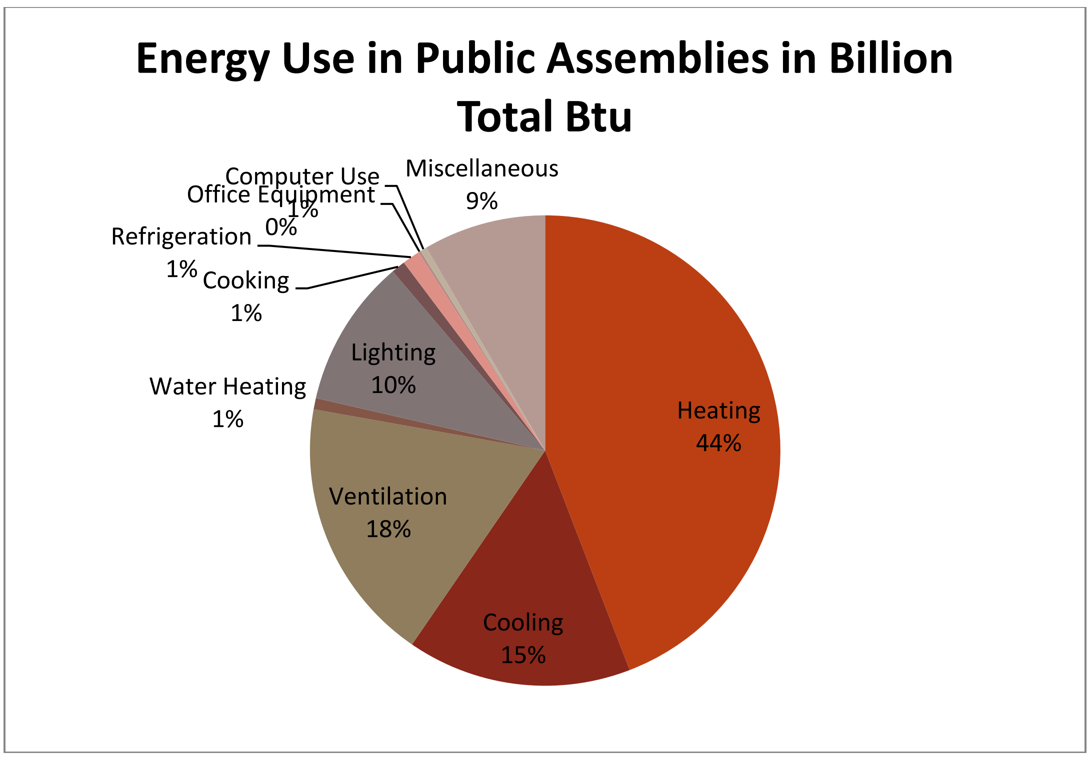

Figure 5.1: Energy Use in Public Assemblies

Comparison of these values to the American Swedish Institute model values, the calculated values in Trace are higher than the average values found particularly for the lighting loads in the building. Heating loads for the building are much lower compared to the average values, this can be explained because of the use of a geothermal heat pump system instead of a 100 % boiler system used to supply heating to the building. Cooling and miscellaneous loads compare very closely to the values found from Trace and vary only by a couple of percentages. However, the lighting loads for the American Swedish Institute are much larger than the average values. A possible reason for this is the American Swedish Institute's use being a museum and gallery space where artwork is on display, with lighting being provided with different lighting fixtures. Also, since museum's make up such a small amount of the public assembly sector for commercial buildings the lighting loads could vary greatly due to the type of building the American Swedish Institute is.

An analysis was also completed for the main mechanical components operation during peak loads. The peak electrical loads for the water source heat pump and boiler are shown below in Table 5.2. Since the water source heat pumps operate similar to chillers they are expected to have the largest percentage of electrical load during peak hours which is verified below. The boiler uses a very small amount of electricity since it runs primarily on natural gas. Lighting also makes up a large amount of the electrical load on the American Swedish Institute.

Electrical Peak Load			
System		**Electrical Demand (KW)**	**% Total**
Cooling	Water Source Heat Pump	96.60	56.65
Heating	Boiler	2.44	1.43
Fan Equip	A-Lower HP	1.02	0.60
	A-First HP	2.87	1.68
	A-Second HP	2.58	1.51
	T-Lower HP	1.80	1.05
	T-First HP	1.93	1.13
	T-Second HP	2.65	1.55
	T-Third HP	1.19	0.70
Misc	Lighting	55.97	32.83
	Equipment	2.15	1.26
Total		**171.20**	**100**

Table 5.2: Electrical Peak Load Summary

The monthly energy consumption for the American Swedish Institute is shown in Appendix C. The information provided includes the on peak consumption and on peak demand for electric and gas. Overall building consumption is 46,081 Btu/ (ft^2*year) this is a total building consumption of $2.91x10^9$ Btu/year. Appendix D shows a monthly breakdown for each piece of mechanical equipment used for the central plant. Information provided includes the peak and average energy use for each mechanical component in the American Swedish Institute.

After the energy usage was complete, the annual cost for operation of the building was calculated. The annual cost breakdown for electricity is shown below in Table 5.3. As seen in the table below, electricity is the major expenditure for the American Swedish Institute with a cost of $2,524,210. Overall operational cost for the building is $2,524,853. The annual operating costs for the building are also shown in the graph in Figure 5.2. Monthly costs for the American Swedish Institute are shown in Figure 5.3 below. As seen in the graph below, there is fluctuation in the spring and fall months as the systems are supplying both heating and cooling. This could be due to the mechanical systems having to deal with the warmer and cooler temperatures that occur in those months.

Annual Utility Breakdown		
Source	**Energy (10^6 Btu/Yr)**	**Cost ($/Yr)**
Electricity	2,843.3	2,524,210
Gas	71.2	441
Total	2,914	2,524,853

Table 5.3: Annual Utility Costs

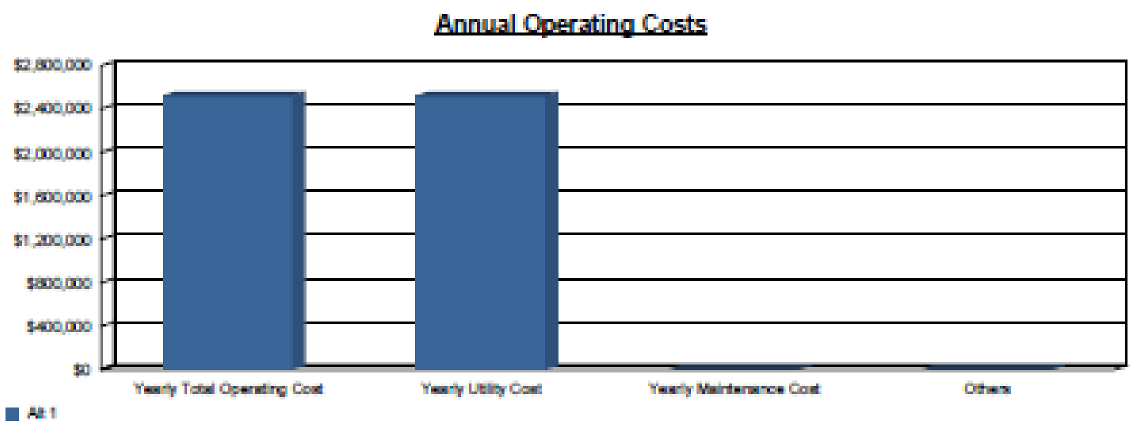

Figure 5.2: Annual Operating Costs

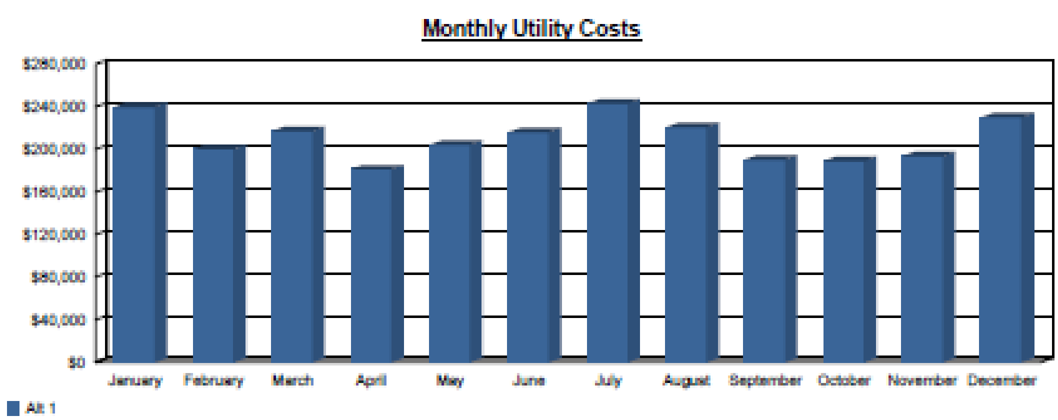

Figure 5.3: Monthly Utility Costs

After completion of the energy analysis for the American Swedish Institute the annual emissions footprint was determined. This information was found from the reference document Regional Grid Emission Factors 2007, where emission factors were determined for electricity and natural gas based on location. The location for the American Swedish Institute is determined to be Eastern since the building is located in Minneapolis, MN and can be seen below in Figure 5.4. The respective emission factors for Eastern were then used to determine the annual pounds of CO_2, NO_x, SO_x, PM10; results for these pollutants are shown below in Table 5.4. The natural gas emission factors were also determined for the boiler used in the American Swedish Institute; the results for the natural gas pollutants can be seen in Table 5.5 below.

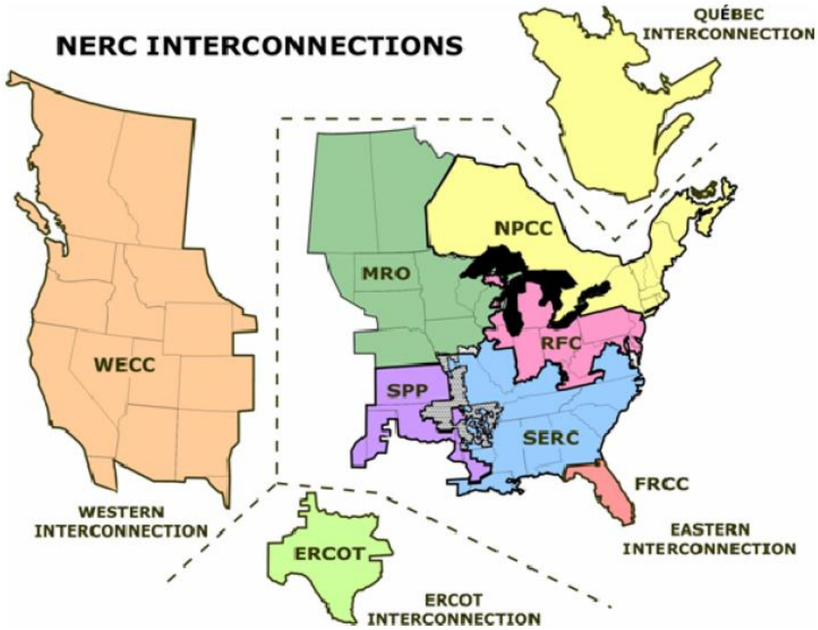

Figure 5.4: United States Electrical Grid Interconnections

Electricity Emissions Factors			
Pollutant	lb of pollutant per kWh of electricity	Electric kWh per year	lb of pollutant
CO_2	1.64	833,073	1,366,240
NO_x	3.00E-03		2,499
SO_x	8.57E-03		7,139
PM10	9.26E-05		77

Table 5.4: Emission Factors for Electricity

Natural Gas Emissions Factors			
Pollutant	Natural Gas per 1,000 cf	Natural Gas cf	lb of pollutant
CO_2	1.22E+02	6,570,000	801,540
NO_x	1.11E-01		72,927
SO_x	6.32E-04		4
PM10	8.40E-03		55

Table 5.5: Emission Factors for Natural Gas

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Appendix A – Weather Data for Minneapolis, MN

2005 ASHRAE Handbook - Fundamentals (IP)

Design conditions for MINNEAPOLIS/ST.PAUL, MN, USA

Station Information

Station name	WMO#	Lat	Long	Elev	StdP	Hours +/- UTC	Time zone code	Period
1a	1b	1c	1d	1e	1f	1g	1h	1i
MINNEAPOLIS/ST.PAUL	726580	44.87N	93.22W	837	14.257	-6.00	NAC	7201

Annual Heating and Humidification Design Conditions

Coldest month	Heating DB		Humidification DP/MCDB and HR						Coldest month WS/MCDB				MCWS/PCWD to 99.6% DB	
			99.6%			99%			0.4%		1%			
	99.6%	99%	DP	HR	MCDB	DP	HR	MCDB	WS	MCDB	WS	MCDB	MCWS	PCWD
2	3a	3b	4a	4b	4c	4d	4e	4f	5a	5b	5c	5d	6a	6b
1	-14.9	-9.4	-25.7	1.4	-14.0	-19.7	1.9	-8.2	27.9	13.6	25.2	12.3	8.7	310

Annual Cooling, Dehumidification, and Enthalpy Design Conditions

Hottest month	Hottest month DB range	Cooling DB/MCWB						Evaporation WB/MCDB						MCWS/PCWD to 0.4% DB	
		0.4%		1%		2%		0.4%		1%		2%			
		DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	WB	MCDB	MCWS	PCWD
7	8	9a	9b	9c	9d	9e	9f	10a	10b	10c	10d	10e	10f	11a	11b
7	18.6	91.0	73.2	87.8	71.8	85.0	70.1	76.7	87.2	74.7	84.2	72.7	81.9	13.9	180

Dehumidification DP/MCDB and HR									Enthalpy/MCDB					
0.4%			1%			2%			0.4%		1%		2%	
DP	HR	MCDB	DP	HR	MCDB	DP	HR	MCDB	Enth	MCDB	Enth	MCDB	Enth	MCDB
12a	12b	12c	12d	12e	12f	12g	12h	12i	13a	13b	13c	13d	13e	13f
73.3	127.8	83.4	71.3	119.3	81.1	69.4	111.3	79.0	33.0	87.6	31.0	84.2	29.2	81.9

Extreme Annual Design Conditions

Extreme Annual WS			Extreme Max WB	Extreme Annual DB				n-Year Return Period Values of Extreme DB							
				Mean		Standard deviation		n=5 years		n=10 years		n=20 years		n=50 years	
1%	2.5%	5%		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
14a	14b	14c	15	16a	16b	16c	16d	17a	17b	17c	17d	17e	17f	17g	17h
24.8	21.6	19.5	83.5	96.5	-20.8	3.6	5.7	99.1	-24.9	101.2	-28.2	103.2	-31.4	105.8	-35.6

Monthly Design Dry Bulb and Mean Coincident Wet Bulb Temperatures

%	Jan		Feb		Mar		Apr		May		Jun	
	DB	MCWB	DB	MCWB	DB	MCWB	DB	MCWB	DB	MCWB	DB	MCWB
	18a	18b	18c	18d	18e	18f	18g	18h	18i	18j	18k	18l
0.4%	42.6	37.2	51.9	44.8	66.3	55.9	81.2	61.2	88.4	66.3	93.2	72.3
1%	39.7	35.1	47.4	41.2	61.8	52.3	77.0	59.3	85.9	65.4	90.9	71.8
2%	37.6	33.7	44.2	39.5	57.9	48.9	73.6	57.4	83.3	64.5	88.7	70.7

%	Jul		Aug		Sep		Oct		Nov		Dec	
	DB	MCWB	DB	MCWB	DB	MCWB	DB	MCWB	DB	MCWB	DB	MCWB
	18m	18n	18o	18p	18q	18r	18s	18t	18u	18v	18w	18x
0.4%	96.6	75.4	94.1	75.9	89.3	72.5	79.6	62.5	66.4	54.9	49.4	44.2
1%	94.0	75.1	90.8	74.5	86.3	70.8	75.7	61.0	62.1	54.2	44.9	39.8
2%	91.8	74.1	88.7	74.0	83.7	69.7	72.3	60.1	59.0	51.9	42.0	37.3

Monthly Design Wet Bulb and Mean Coincident Dry Bulb Temperatures

%	Jan		Feb		Mar		Apr		May		Jun	
	WB	MCDB	WB	MCDB	WB	MCDB	WB	MCDB	WB	MCDB	WB	MCDB
	19a	19b	19c	19d	19e	19f	19g	19h	19i	19j	19k	19l
0.4%	37.6	42.0	44.7	50.3	57.3	63.6	63.9	76.1	70.9	82.2	76.9	88.2
1%	35.7	38.8	42.6	47.1	54.1	60.6	62.0	73.3	69.1	79.6	75.4	85.3
2%	34.3	36.7	39.8	43.7	51.0	55.6	59.9	69.7	67.7	78.0	74.1	83.9

%	Jul		Aug		Sep		Oct		Nov		Dec	
	WB	MCDB	WB	MCDB	WB	MCDB	WB	MCDB	WB	MCDB	WB	MCDB
	19m	19n	19o	19p	19q	19r	19s	19t	19u	19v	19w	19x
0.4%	79.7	90.1	78.8	89.2	75.0	85.9	66.7	74.0	58.2	63.1	46.2	48.5
1%	78.2	89.3	77.4	87.8	73.3	83.1	64.2	71.5	55.5	60.5	40.7	44.5
2%	77.2	88.3	76.2	85.7	71.7	80.3	62.2	69.9	53.0	57.8	37.6	40.9

Monthly Mean Daily Temperature Range

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20a	20b	20c	20d	20e	20f	20g	20h	20i	20j	20k	20l
15.9	15.3	15.7	19.1	19.8	19.5	18.6	17.9	18.6	18.0	14.0	14.2

WMO#	World Meteorological Organization number	Lat	Latitude, °	Long	Longitude, °
Elev	Elevation, ft	StdP	Standard pressure at station elevation, psi		
DB	Dry bulb temperature, °F	DP	Dew point temperature, °F	WB	Wet bulb temperature, °F
WS	Wind speed, mph	Enth	Enthalpy, Btu/lb	HR	Humidity ratio, grains of moisture per lb of dry air
MCDB	Mean coincident dry bulb temperature, °F	MCDP	Mean coincident dew point temperature, °F	MCWB	Mean coincident wet bulb temperature, °F
MCWS	Mean coincident wind speed, mph	PCWD	Prevailing coincident wind direction, °, 0 = North, 90 = East		

Appendix B – Minnesota Rates

Electrical RATES

Customer Charge per Month	Unmetered (A09)	$7.15
	Metered (A10)	$8.65
	Water Heating (A11)	$0.00
	Direct Current (A13)	$8.65
Energy Charge per kWh		
	June - September	$0.07173
	Other Months	$0.06175
Demand Charge (Direct Current Only) per Month per kW of Connected Load		**$3.03**

RATE

Where annual usage
Small – less than 6,000 Therms
Large – at least 6,000 Therms

Peak daily demand requirements of less than 500 Therms

	SMALL	LARGE
Customer Charge per Month	$25.00	$50.00
Distribution Charge per Therm	$0.123310	$0.123151
Base Cost of Gas per Therm		
April - October	**$0.59440**	$0.59440
November - March	**$0.65221**	$0.65221

Appendix C – Monthly Energy Consumption

Monthly Energy Consumption														
Utility		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Total**
Electric	On-Peak Cons (kWh)	79,097	65,933	71,696	59,736	67,367	71,298	80,288	72,836	62,774	62,831	75,867	75,867	**833,073**
	On-Peak Demand (kW)	171	166	161	149	133	149	165	150	130	150	157	168	**171**
Gas	On-Peak Cons (therms)	313	97	76	0	0	0	0	0	0	0	9	217	**712**
	On-Peak Demand (therms/yr)	2	1	1	0	0	0	0	0	0	0	1	2	**2**

Appendix D – Equipment Energy Consumption

Alternative: 1 ASI Loads

------ Monthly Consumption ------

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Lights													
Electric (kWh)	41,644.5	37,614.4	41,644.4	40,301.1	41,644.4	40,301.1	41,644.4	41,644.4	40,301.1	41,644.4	40,301.1	41,644.5	490,329.9
Peak (kW)	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0
Misc. Ld													
Electric (kWh)	1,600.3	1,445.5	1,600.3	1,548.7	1,600.3	1,548.7	1,600.3	1,600.3	1,548.7	1,600.3	1,548.7	1,600.3	18,842.8
Peak (kW)	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Cooling Coil Condensate													
Recoverable Water (1000gal)	0.4	0.4	0.5	1.2	3.1	5.1	8.7	5.7	3.7	1.7	0.9	0.4	31.7
Peak (1000gal/Hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cpl 1: Cooling plant - 001 [Sum of dsn coil capacities=156.3 tons]													
Water source heat pump - 001 [Clg Nominal Capacity/F.L.Rate=156.3 tons / 118.9 kW] (Cooling Equipment - Cooling Mode)													
Electric (kWh)	3,263.0	3,133.7	3,621.1	5,378.6	13,666.4	19,329.9	26,587.3	19,135.7	10,738.1	6,285.3	4,158.3	3,240.4	118,537.7
Peak (kW)	13.8	14.3	14.3	23.7	60.7	77.2	92.5	77.6	56.8	25.8	17.8	13.9	92.5
Water source heat pump - 001 [Htg Nominal Capacity/F.L.Rate=1,700 mbh / 108.3 kW] (Cooling Equipment - Heating Mode)													
Electric (kWh)	20,719.7	13,466.5	13,543.1	2,388.7	0.0	0.0	0.0	0.0	67.3	2,363.5	7,675.0	17,634.6	77,858.3
Peak (kW)	85.1	76.7	72.2	55.2	4.3	0.0	0.0	0.0	3.7	55.1	66.3	80.7	85.1
Wshpcntl - WS heat pump control (Misc Accessory Equipment)													
Electric (kWh)	18.6	16.8	18.6	18.0	18.6	18.0	18.6	18.6	18.0	18.6	18.0	18.6	219.0
Peak (kW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hpl 1: Heating plant - 002 [Sum of dsn coil capacities=1,936 mbh]													
Boiler - 001 [Nominal Capacity/F.L.Rate=1,936 mbh / 23.25 Therms] (Heating Equipment)													
Gas (therms)	312.8	96.9	75.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1	217.3	711.9
Peak (therms/Hr)	2.3	1.1	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.6	2.3
Boiler forced draft fan (Misc Accessory Equipment)													
Electric (kWh)	1,123.3	658.5	660.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.2	1,026.5	3,491.9
Peak (kW)	1.9	1.9	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.9	1.9
Cntl panel & interlocks - 0.5 KW (Misc Accessory Equipment)													
Electric (kWh)	290.0	170.0	170.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	265.0	901.5
Peak (kW)	0.5	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5
Sys 1: A-First HP													

Alternative: 1 ASI Loads

------ Monthly Consumption ------

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Sys 1: A-First HP													
Hydronic in heat pump fan [DsnAirflow/F.L.Rate=10,899 cfm / 2.87 kW] (Main Clg Fan)													
Electric (kWh)	2,135.4	1,928.8	2,135.4	2,066.5	2,135.4	2,066.5	2,135.4	2,135.4	2,066.5	2,135.4	2,066.5	2,135.4	25,142.9
Peak (kW)	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Sys 2: A-Lower HP													
Hydronic in heat pump fan [DsnAirflow/F.L.Rate=3,873 cfm / 1.02 kW] (Main Clg Fan)													
Electric (kWh)	758.9	685.5	758.9	734.4	758.9	734.4	758.9	758.9	734.4	758.9	734.4	758.9	8,935.6
Peak (kW)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Sys 3: A-Second HP													
Hydronic in heat pump fan [DsnAirflow/F.L.Rate=9,780 cfm / 2.58 kW] (Main Clg Fan)													
Electric (kWh)	1,916.2	1,730.7	1,916.2	1,854.4	1,916.2	1,854.4	1,916.2	1,916.2	1,854.4	1,916.2	1,854.4	1,916.2	22,561.4
Peak (kW)	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Sys 4: T-First HP													
Hydronic in heat pump fan [DsnAirflow/F.L.Rate=7,319 cfm / 1.93 kW] (Main Clg Fan)													
Electric (kWh)	1,434.0	1,295.2	1,434.0	1,387.7	1,434.0	1,387.7	1,434.0	1,434.0	1,387.7	1,434.0	1,387.7	1,434.0	16,883.7
Peak (kW)	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Sys 5: T-Lower HP													
Hydronic in heat pump fan [DsnAirflow/F.L.Rate=6,822 cfm / 1.80 kW] (Main Clg Fan)													
Electric (kWh)	1,336.6	1,207.2	1,336.6	1,293.5	1,336.6	1,293.5	1,336.6	1,336.6	1,293.5	1,336.6	1,293.5	1,336.6	15,737.3
Peak (kW)	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Sys 6: T-Second HP													
Hydronic in heat pump fan [DsnAirflow/F.L.Rate=10,048 cfm / 2.65 kW] (Main Clg Fan)													
Electric (kWh)	1,968.8	1,778.3	1,968.8	1,905.3	1,968.8	1,905.3	1,968.8	1,968.8	1,905.3	1,968.8	1,905.3	1,968.8	23,180.8
Peak (kW)	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Sys 7: T-Third HP													
Hydronic in heat pump fan [DsnAirflow/F.L.Rate=4,529 cfm / 1.19 kW] (Main Clg Fan)													
Electric (kWh)	887.5	801.6	887.5	858.9	887.5	858.9	887.5	887.5	858.9	887.5	858.9	887.5	10,449.7
Peak (kW)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

Appendix E – Engineering Checks

System	Zone	Room	Type	Floor Area ft²	COOLING % OA	COOLING cfm/ft²	COOLING cfm/ton	COOLING ft²/ton	COOLING Btu/hr·ft²	HEATING % OA	HEATING cfm/ft²	HEATING Btu/hr·ft²
Alternative 1												
		A-First Studio Classroom	Room	780	58.61	1.06	209.4	198.0	60.62	58.61	1.06	-65.69
	Zone - 001		Zone	780	58.61	1.06	209.4	198.0	60.62	58.61	1.06	-65.69
		A-First Gustavus Interior Office	Room	570	9.64	0.30	275.7	933.1	12.86	32.14	0.30	-13.95
	Zone - 002		Zone	570	9.64	0.30	275.7	933.1	12.86	32.14	0.30	-13.95
		A-First Gustavus Exterior Office	Room	240	7.01	1.35	459.9	339.6	35.33	7.01	1.35	-24.82
		A-First Restroom	Room	600	0.00	0.24	368.1	1,531.5	7.84	0.00	0.24	-6.00
	Zone - 003		Zone	840	4.86	0.56	427.1	764.8	15.69	4.86	0.56	-11.37
		A-First Coat Hallway	Room	350	7.11	0.84	452.0	535.2	22.42	7.11	0.84	-17.01
		A-First Hallway	Room	1,200	3.40	1.77	490.4	277.7	43.22	3.40	1.77	-33.13
	Zone - 004		Zone	1,550	3.85	1.56	485.3	311.5	38.52	3.85	1.56	-29.49
		A-First Lobby/Event	Room	1,500	22.58	1.37	279.1	203.4	59.01	22.58	1.37	-58.18
		A-First Lobby/Ticket	Room	150	14.00	0.24	213.2	904.5	13.27	46.67	0.24	-15.11
	Zone - 005		Zone	1,650	22.44	1.27	277.7	218.8	54.85	22.99	1.27	-54.26
		A-First Cafe	Room	1,000	21.16	0.68	158.0	232.2	51.68	70.54	0.68	-49.04
	Zone - 006		Zone	1,000	21.16	0.68	158.0	232.2	51.68	70.54	0.68	-49.04
		A-First Gallery	Room	1,187	16.86	0.95	381.6	402.1	29.84	16.86	0.95	-34.88
	Zone - 007		Zone	1,187	16.86	0.95	381.6	402.1	29.84	16.86	0.95	-34.88
		A-First Gift Shop	Room	860	63.51	0.54	190.7	350.8	34.21	63.51	0.54	-38.89
	Zone - 008		Zone	860	63.51	0.54	190.7	350.8	34.21	63.51	0.54	-38.89
		A-First Conference	Room	1,000	33.79	0.92	258.5	281.8	42.59	33.79	0.92	-37.87
	Zone - 009		Zone	1,000	33.79	0.92	258.5	281.8	42.59	33.79	0.92	-37.87
		A-First Kitchen	Room	1,099	22.94	1.11	345.0	310.4	38.67	22.94	1.11	-30.86
	Zone - 010		Zone	1,099	22.94	1.11	345.0	310.4	38.67	22.94	1.11	-30.86
		A-First Exterior Office	Room	150	8.94	1.06	441.1	415.3	28.90	8.94	1.06	-21.85
		A-First Multi Purpose	Room	170	12.56	0.74	228.9	309.0	38.83	41.85	0.74	-34.46
		A-First Shipping/Receiving	Room	152	0.00	1.16	496.9	429.3	27.95	0.00	1.16	-26.56
	Zone - 011		Zone	472	6.52	0.98	364.5	373.0	32.17	14.52	0.98	-27.91
		A-First Interior Office	Room	110	9.64	0.30	275.7	933.1	12.86	32.14	0.30	-13.95
		A-First Storage	Room	75	0.00	0.27	316.4	1,161.3	10.33	0.00	0.27	-4.98
	Zone - 012		Zone	185	5.92	0.29	290.1	1,013.9	11.84	19.73	0.29	-10.31
A-First HP			System - Water Source Heat Pump	11,193	18.87	0.87	288.3	307.4	39.04	26.41	0.87	-37.06
		A-Lower Electrical	Room	420	2.25	2.67	528.7	198.0	60.61	2.25	2.67	-9.68
	Zone - 013		Zone	420	2.25	2.67	528.7	198.0	60.61	2.25	2.67	-9.68
		A-Lower Mechanical	Room	550	0.00	0.50	529.1	1,054.5	11.38	0.00	0.50	0.00
	Zone - 014		Zone	550	0.00	0.50	529.1	1,054.5	11.38	0.00	0.50	0.00
		A-Lower Elev Equip 1	Room	100	2.17	2.76	515.5	186.6	64.32	2.17	2.76	-9.68
	Zone - 015		Zone	100	2.17	2.76	515.5	186.6	64.32	2.17	2.76	-9.68
		A-Lower Exhibit Prep	Room	500	0.00	0.57	488.3	855.9	14.02	0.00	0.57	-4.43

System	Zone	Room	Type	Floor Area ft²	COOLING % OA	COOLING cfm/ft²	COOLING cfm/ton	COOLING ft²/ton	COOLING Btu/hr·ft²	HEATING % OA	HEATING cfm/ft²	HEATING Btu/hr·ft²
		A-Lower Exhibit Shop	Room	685	35.06	0.57	301.8	529.1	22.68	35.06	0.57	-20.50
		A-Lower Maint Mat Storage	Room	250	0.00	0.21	400.0	1,951.1	6.15	0.00	0.21	-4.43
	Zone - 016		Zone	1,435	18.84	0.51	362.4	715.0	16.78	18.84	0.51	-12.10
		A-Lower Quarantine	Room	320	35.06	0.57	301.8	529.1	22.68	35.06	0.57	-20.50
	Zone - 017		Zone	320	35.06	0.57	301.8	529.1	22.68	35.06	0.57	-20.50
		A-Lower Art Storage	Room	2,400	0.00	0.21	434.0	2,117.1	5.67	0.00	0.21	-4.43
	Zone - 018		Zone	2,400	0.00	0.21	434.0	2,117.1	5.67	0.00	0.21	-4.43
		A-Lower C Workroom	Room	450	31.45	0.30	282.0	933.9	12.85	31.45	0.30	-12.01
		A-Lower Exhibit Storage	Room	190	0.00	0.21	377.6	1,841.9	6.52	0.00	0.21	-4.43
	Zone - 019		Zone	640	24.44	0.27	298.8	1,094.0	10.97	24.44	0.27	-9.76
		A-Lower Retail/Storage	Room	1,015	0.00	0.21	430.1	2,097.8	5.72	0.00	0.21	-4.43
	Zone - 020		Zone	1,015	0.00	0.21	430.1	2,097.8	5.72	0.00	0.21	-4.43
		A-Lower Elev Equip 2	Room	80	2.15	2.79	511.5	183.1	65.54	2.15	2.79	-9.68
	Zone - 021		Zone	80	2.15	2.79	511.5	183.1	65.54	2.15	2.79	-9.68
		A-Lower Exhibit F Storage	Room	340	0.00	0.21	411.2	2,005.6	5.98	0.00	0.21	-4.43
		A-Lower Table/Chair Storage	Room	300	0.00	0.21	407.2	1,986.0	6.04	0.00	0.21	-4.43
	Zone - 022		Zone	640	0.00	0.21	409.3	1,996.4	6.01	0.00	0.21	-4.43
		A-Lower Building Engineer	Room	200	31.45	0.30	282.0	933.9	12.85	31.45	0.30	-12.01
	Zone - 023		Zone	200	31.45	0.30	282.0	933.9	12.85	31.45	0.30	-12.01
A-Lower HP			**System - Water Source Heat Pump**	**7,800**	**7.71**	**0.60**	**432.1**	**870.1**	**13.79**	**7.71**	**0.60**	**-7.22**
		A-Second Event Space	Room	3,800	16.86	1.84	326.8	177.7	67.52	16.86	1.84	-43.57
	Zone - 024		Zone	3,800	16.86	1.84	326.8	177.7	67.52	16.86	1.84	-43.57
		A-Second Kitchen	Room	800	22.87	1.12	346.1	310.3	38.67	22.87	1.12	-26.70
	Zone - 025		Zone	800	22.87	1.12	346.1	310.3	38.67	22.87	1.12	-26.70
		A-Second Prefunction	Room	1,800	11.51	0.96	407.9	426.9	28.11	11.51	0.96	-30.56
	Zone - 026		Zone	1,800	11.51	0.96	407.9	426.9	28.11	11.51	0.96	-30.56
		A-Second Hallway Coat Room	Room	152	5.36	0.34	361.7	1,078.0	11.13	17.88	0.34	-12.37
		A-Second Restroom	Room	520	0.00	0.25	361.8	1,457.8	8.23	0.00	0.25	-5.53
	Zone - 027		Zone	672	1.52	0.27	361.8	1,350.2	8.89	5.06	0.27	-7.08
A-Second HP			**System - Water Source Heat Pump**	**7,072**	**18.18**	**1.38**	**341.1**	**248.8**	**48.86**	**18.26**	**1.38**	**-34.88**
	T-First Gallery		Zone	10,100	11.73	0.72	377.7	521.2	23.02	11.73	0.72	-33.19
T-First HP			**System - Water Source Heat Pump**	**10,100**	**11.73**	**0.72**	**377.7**	**521.2**	**23.02**	**11.73**	**0.72**	**-33.19**
		T-Lower Community Hall	Room	1,660	40.46	0.77	237.9	310.5	38.65	40.46	0.77	-34.33
	Zone - 028		Zone	1,660	40.46	0.77	237.9	310.5	38.65	40.46	0.77	-34.33
		T-Lower Classroom B	Room	500	79.77	0.78	153.5	197.5	60.77	79.77	0.78	-56.54
	Zone - 029		Zone	500	79.77	0.78	153.5	197.5	60.77	79.77	0.78	-56.54
		T-Lower Classroom A	Room	750	79.77	0.78	153.5	197.5	60.77	79.77	0.78	-56.54
	Zone - 030		Zone	750	79.77	0.78	153.5	197.5	60.77	79.77	0.78	-56.54
		T-Lower Ed Workroom	Room	137	22.36	0.42	336.0	791.0	15.17	22.36	0.42	-17.17
	Zone - 031		Zone	137	22.36	0.42	336.0	791.0	15.17	22.36	0.42	-17.17
		T-Lower Kitchen	Room	180	22.52	1.13	355.3	313.8	38.24	22.52	1.13	-31.14
	Zone - 032		Zone	180	22.52	1.13	355.3	313.8	38.24	22.52	1.13	-31.14
		T-Lower Ed Storage	Room	210	0.00	0.42	453.2	1,067.0	11.25	0.00	0.42	-9.64

System	Zone	Room	Type	Floor Area ft²	COOLING % OA	COOLING cfm/ft²	COOLING cfm/ton	COOLING ft²/ton	COOLING Btu/hr-ft²	HEATING % OA	HEATING cfm/ft²	HEATING Btu/hr-ft²
		T-Lower Volunteer Lounge	Room	510	30.34	1.02	274.0	268.2	44.74	30.34	1.02	-47.61
	Zone - 033		Zone	720	25.91	0.85	290.9	343.2	34.97	25.91	0.85	-36.53
		T-Lower Hallway	Room	1,600	14.13	0.42	396.6	933.8	12.85	14.13	0.42	-14.46
		T-Lower Restroom	Room	540	0.00	0.42	437.4	1,029.6	11.65	0.00	0.42	-9.64
	Zone - 034		Zone	2,140	10.56	0.42	406.2	956.3	12.55	10.56	0.42	-13.25
		T-Lower Art 3D	Room	2,400	0.00	0.47	412.7	886.8	13.53	0.00	0.47	-10.56
		T-Lower Storage	Room	230	0.00	0.35	361.6	1,031.9	11.63	0.00	0.35	-7.95
	Zone - 035		Zone	2,630	0.00	0.46	408.8	897.9	13.37	0.00	0.46	-10.33
		T-Lower Archive	Room	660	0.00	0.35	371.2	1,059.4	11.33	0.00	0.35	-7.95
		T-Lower Art Storage 2D	Room	450	0.00	0.76	448.6	589.9	20.34	0.00	0.76	-17.26
	Zone - 036		Zone	1,110	0.00	0.52	413.8	801.0	14.98	0.00	0.52	-11.72
		T-Lower Gallery	Room	640	24.26	0.35	318.4	908.5	13.21	24.26	0.35	-14.63
	Zone - 037		Zone	640	24.26	0.35	318.4	908.5	13.21	24.26	0.35	-14.63
		T-Lower Library	Room	515	0.00	0.35	356.5	1,017.4	11.79	0.00	0.35	-7.95
	Zone - 038		Zone	515	0.00	0.35	356.5	1,017.4	11.79	0.00	0.35	-7.95
		T-Lower Misc	Room	800	79.77	0.78	153.5	197.5	60.77	79.77	0.78	-56.54
	Zone - 039		Zone	800	79.77	0.78	153.5	197.5	60.77	79.77	0.78	-56.54
T-Lower HP			**System - Water Source Heat Pump**	**11,782**	**31.68**	**0.68**	**258.0**	**447.4**	**28.82**	**31.68**	**0.68**	**-24.64**
	T-Second Gallery E		Zone	2,175	6.08	1.40	425.2	304.3	39.44	6.08	1.40	-47.13
	T-Second Gallery N		Zone	2,175	8.65	0.98	403.2	410.1	29.26	8.65	0.98	-42.91
	T-Second Gallery S		Zone	2,175	9.02	0.94	405.5	430.2	27.89	9.02	0.94	-41.41
	T-Second Gallery W		Zone	2,175	6.55	1.30	411.3	317.1	37.85	6.55	1.30	-45.65
T-Second HP			**System - Water Source Heat Pump**	**8,700**	**7.38**	**1.16**	**412.4**	**357.0**	**33.61**	**7.38**	**1.16**	**-44.27**
	T-Third Gallery		Zone	6,600	12.38	0.69	372.9	543.4	22.08	12.38	0.69	-31.72
T-Third HP			**System - Water Source Heat Pump**	**6,600**	**12.38**	**0.69**	**372.9**	**543.4**	**22.08**	**12.38**	**0.69**	**-31.72**