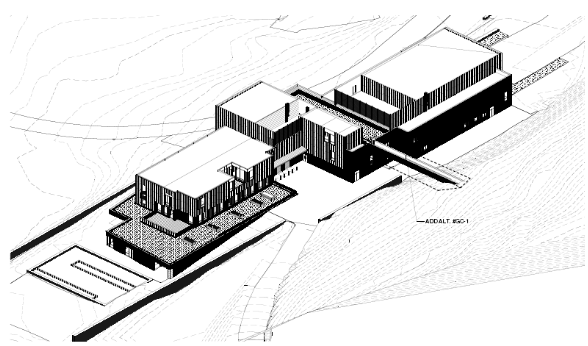
Technical Assignment 2

Building and Plant Energy Analysis Report

Slippery Rock University Student Union

Slippery Rock, PA



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Executive Summary

This technical assignment was set out to determine the Slippery Rock University Student Union interior loads along with the cost of operation of the building. In order to find these pieces of information, various drawings, documents, and relevant building characteristics were put together into Trane TRACE to complete an energy model. When certain pieces of information were unavailable, assumptions were made based on reasonable traditional values of design or the ASHRAE Fundamental Handbook.

The first section of the assignment was to find the Slippery Rock University Student Union internal loads. The loads estimated from Trane TRACE were within reason. However, it appears the building has an oversized mechanical system in most cases. There were some discrepancies between the design and estimated building. Some of these differences can be attributed to the differences in area that were put into Trane TRACE and what the actual designed total area is.

The second part of the assignment was to investigate the cost analysis of operation in the building. The equipment that took up the most of the energy consumption was the supply fans, using over 1/3 of the total energy consumed by the building. The heating and cooling loads were about equal and between 10 to 15 percent each. The lighting and receptacle loads were also very similar to one another at 20 percent each.

The model has been simplified in order to obtain the necessary data. Some information has been assumed, which can account for the differences between the estimated and designed load. Overall, the energy model is a generally close representation of the Slippery Rock Student Union internal energy loads.

Mechanical Summary

The Slippery Rock University Student Union will use highly efficient mechanical systems to ventilate, heat, and air condition the spaces in order to provide a comfortable environment for its occupants. The basis of the system contains three major components that allow for the system as a whole to run effectively.

First, the heat pump water transfer system allows for energy to be transferred between spaces for simultaneous heating and cooling throughout the year. This allows for direct heat exchange between the five different energy recovery units without the cost and consumption of energy associated with producing or removing that heat. The heat pumps are equipped to run with variable frequency drives in order to increase efficiency and reduce speed when the building loads are low. Due to the nature of the building, this is one of several key elements that will help to improve efficiency and cut energy costs and consumption.

The second component that enables the system to run well is the use of energy wheels in the energy recovery units. There are five energy recovery units, each containing an energy wheel that captures otherwise wasted exhaust energy and transfers it to the incoming air that is used to supply the building with outdoor air. These units are equipped with an economizer in order to allow up to 25 percent outsize air. This decreases the load on the need to heat or cool the new supply air therefore needing less auxiliary power to heat or condition the air.

Last, the use of the variable air volume fans allow to change the speed of the fan based on the conditions of the space. Each space has a temperature control and an allotted variable volume box with hot water coils in order to allow for occupants comfort and control. This helps to save on electrical costs by decreasing the energy output when internal loads are low.

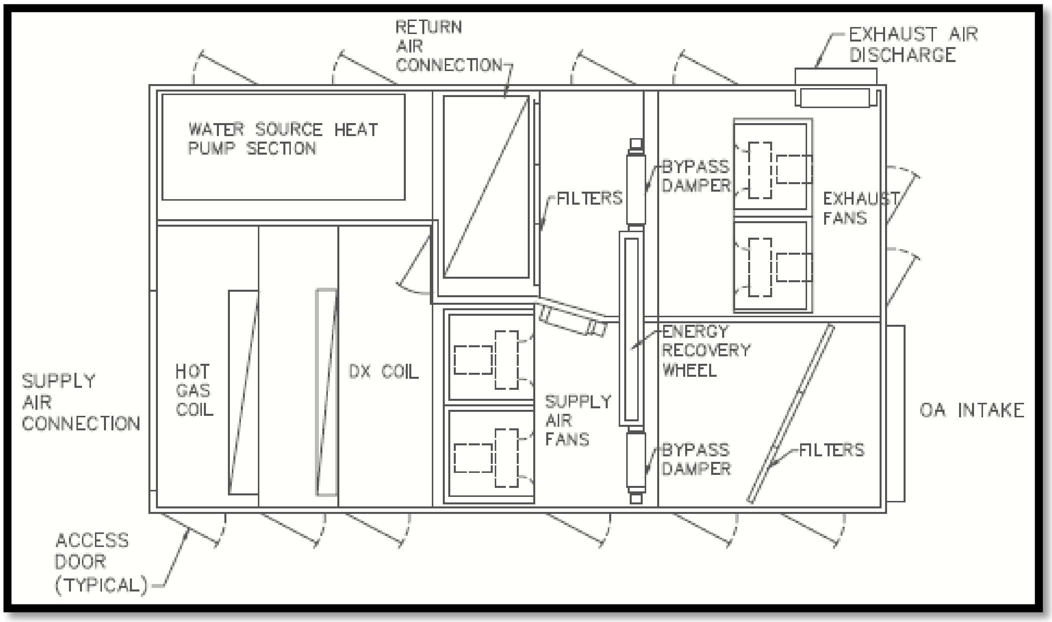


Figure 1 - Energy Recovery Unit Plan

As shown in the diagram, each ERU is equipped with prefilters and MERV 15 filters, an energy recovery wheel, supply and exhaust fans, variable frequency drives, a water source heat pump section and various controls.

Five energy recovery units are used to serve all the ventilation requirements in the building. Four of which are located on the roof with the remaining energy recovery unit located indoors on the first floor servicing the bookstore, bookstore storage, and bookstore offices. There are also three make-up air units located on the roof to account for the kitchen hood exhausts. The electrical and mechanical rooms are serviced using a ductless split system.

The use of other auxiliary systems allows the building to maintain occupant comfort and wellbeing during the extreme and peak load conditions. The use of the nearby university steam plant is used for heating during peak loads in the winter. With the use of shell and tube heat exchangers, the steam is converted into water transferring heat to the water source transfer system. During peak cooling loads, the use of two cooling towers will assist in allowing heat to escape from the water transfer system.

Design Load Estimation

Assumptions:

Energy Simulation Program

The energy analysis program designed by Trane program called TRACE 700 was used to determine the load estimation, the annual energy consumption and operating costs of the Slippery Rock University Student Union. The drawings and schedules provide the necessary information in order to develop an energy model. The model is designed to include each room, as well as the circulation spaces while incorporating a system similar to the described in the Mechanical Summary. Using the TRACE model, one can accurately determine the loads throughout the year in various locations.

Outdoor and Indoor Design Conditions

The following design conditions were used based on the design conditions specific to the location. These design conditions are based on weather data supplied for Pittsburgh, PA because weather conditions for Slippery Rock, PA were unavailable.

Table 1 – Outdoor Design Conditions

Outdoor Design Conditions	
Location	Pittsburgh, Pa
Summer Dry Bulb (°F)	86
Summer Wet Bulb (°F)	71
Winter Dry Bulb (°F)	5
Summer Clearness	0.97
Summer Ground Reflectance	0.2
Winter Clearness	0.97
Winter Ground Reflectance	0.2
Outdoor Carbon Dioxide Level	400

Table 2 – Indoor Temperature Settings

Indoor Temperatures Settings	
Cooling Dry Bulb (°F)	74
Heating Dry Bulb (°F)	70
Relatives Humidity %	50
Cooling Driftpoint (°F)	80
Heating Driftpoint (°F)	64

Loads and Schedules

Each type of space was given a different internal load based on its function. The building has been laid out to allow common spaces to be located near one another. This simple design allowed for large areas with generally the same internal loads to be modeled in larger zones. It also limits confusing and sporadic ductwork throughout the building. Lighting loads were provided by the engineer, while some miscellaneous and density loads were estimated. The occupancy schedule shown is typical during a spring and fall semester, which was also provided by the engineer. The following table shows the different templates used to determine each spaces internal load.

Table 3 – Space Internal Load Templates

	Ballroom	Conference	Dining	Kitchen	Bank	Bookstore	Corridor	Elec/IT/Mech	Lounge	Office	Auditorium
Density (SF/person)	6.7	20	10	10	143	143	0	0	143	143	6.7
People Sensible (btu/hr)	225	250	275	275	250	250	250	0	250	250	225
People Latent (btu/hr)	105	200	275	275	200	200	250	0	200	200	105
Lighting (W/SF)	0.907	0.907	0.907	0.907	0.907	0.907	0.816	0.907	0.907	0.816	0.907
Misc (W/SF)	0.5	1	0.5	5	1.5	1	1	5	1	1	0.5

Table 4 – Lighting Schedule

Lighting Schedule	
Time	Lights
Midnight - 7am	0
7am - 8am	25
8am - 9am	50
9am - 10pm	100
10pm - 11pm	50
11pm - Midnight	25

Table 5 – Occupancy Schedule

Occupancy Schedule	
Time	People
Midnight - 7am	0
7am - 8am	5
8am - 6pm	50
6pm - 7pm	60
7pm - 8pm	30
7pm - Midnight	10

Zones

The Slippery Rock University Student Union holds various types and varieties of functions throughout the building. The mechanical system is designed to supply these spaces effectively and efficiently as possible by isolating each type of zone. The following list describes which air handler will provide air to the spaces in the building. Figure 3 is a colored floor plan showing where these spaces are located.

- Zone 1: Heating only – This zone only requires the spaces to be heated. It contains the perimeter stairwells, mechanical rooms, and the entry vestibules.
- Zone 2: Energy Recovery Unit 1 – This unit will both heat in the winter and cool in the summer. Located on the roof, the energy recovery unit will provide air to the entrance lobby, café, UPS, cultural lounge, fireplace lounge, theatre, administrative offices, and surrounding corridors.
- Zone 3: Energy Recovery Unit 2 – This unit is also located on the roof and provides both heating and cooling. It serves the dining/cafeteria area, the kitchen support rooms, the servery, storage rooms, and the surrounding corridors.
- Zone 4: Energy Recovery Unit 3 – This energy recovery unit is located on the roof which provides ventilation to the student organization rooms, meeting rooms, and the circulation spaces throughout the area.
- Zone 5: Energy Recovery Unit 4 – This unit is located on the roof providing both heating and cooling. It serves the ballrooms and the pre-function and circulation space surrounding the ballrooms. It also provides ventilation to the supporting storage rooms.
- Zone 6: Energy Recovery Unit 5 – The final energy recovery unit is located indoors on the first floor. This unit serves the bookstore and its storage space and office space.
- Zone 7: Make-Up Air Units – Three make-up air units supply air to the kitchen hoods located on the second floor kitchen. These kitchen hoods exhaust large amounts of air so these units must bring in air in order to keep the space properly ventilated and conditioned.
- Zone 8: Ductless Split System Schedule – This system is used to combat the heat gain that is caused by the electrical and IT spaces located throughout the building. These rooms must be kept at a reasonable temperature in order to keep the equipment from being damaged.

Zone 1 - Green: Heating Only	Zone 5 - Purple: ERU 4
Zone 2 - Light Blue: ERU 1	Zone 6 - Orange: ERU 5
Zone 3 - Yellow: ERU 2	Zone 7 - Pink: Pink
Zone 4 - Dark Blue: ERU 3	Zone 8 - Red: Ductless Split System

Figure 2 – List of Zones

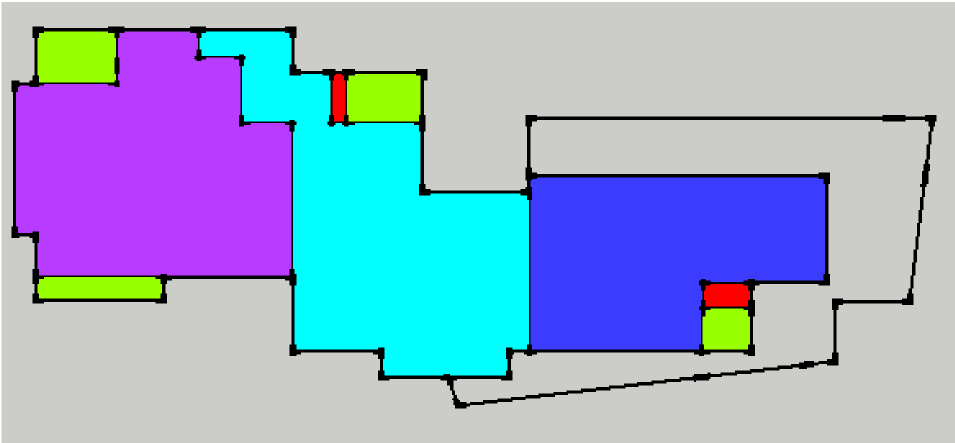


Figure 3 – Third Floor Zone Layout

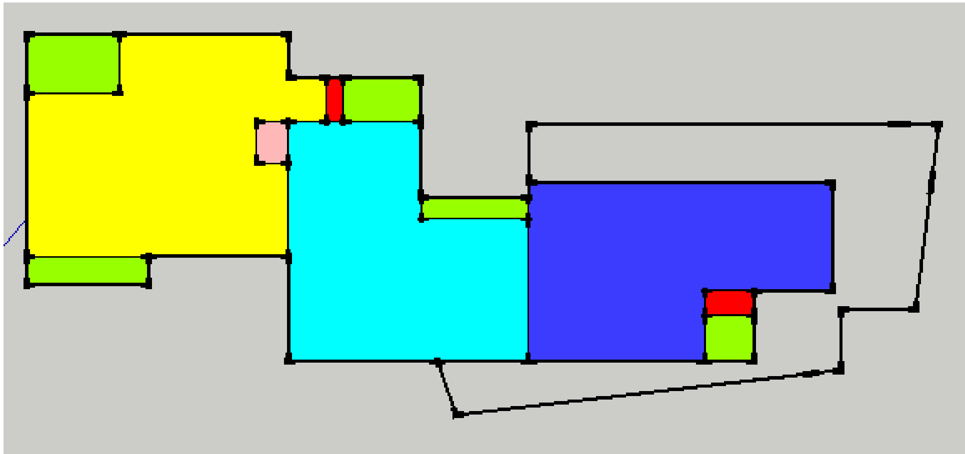


Figure 4 – Second Floor Zone Layout

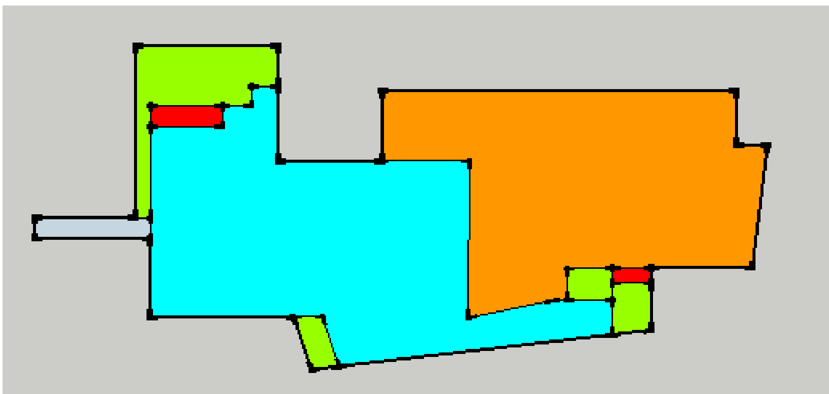


Figure 5 – First Floor Zone Layout

Estimate Load vs. Design Load Comparison

Table 6 – Estimated vs. Design Cooling Capacities

Estimated Load vs. Design Load Cooling Capacities						
Air Handler	CFM		tons		Mbh	
	Estimated	Designed	Estimated	Designed	Estimated	Designed
ERU - 1	22036	24000	72.2	86.8	866.5	1041.6
ERU - 2	10464	16000	34.1	52.1	408.6	625.2
ERU - 3	10636	24000	34.3	78.1	411.5	937.2
ERU - 4	24392	26000	86.2	78.9	1034.8	946.8
ERU - 5	9456	16000	29.8	53.3	357.4	639.6
MAU	12175	12255	0	0	0	0
Split System	1311	18000	2.4	1.5	29.1	36
Totals	90470	136255	259	350.7	3107.9	4226.4

The table shows the difference between the estimated loads from the energy model compared to the design loads calculated. The design loads were calculated by the given cooling entering and leaving air properties along with the designed air flow rates. The following latent and sensible load equations were used to find the total cooling capacity because they were not provided on the schedules.

- $Q_{SENSIBLE} = 1.08 \times CFM \times \Delta T$
- $Q_{LATENT} = 4840 \times CFM \times \Delta w$

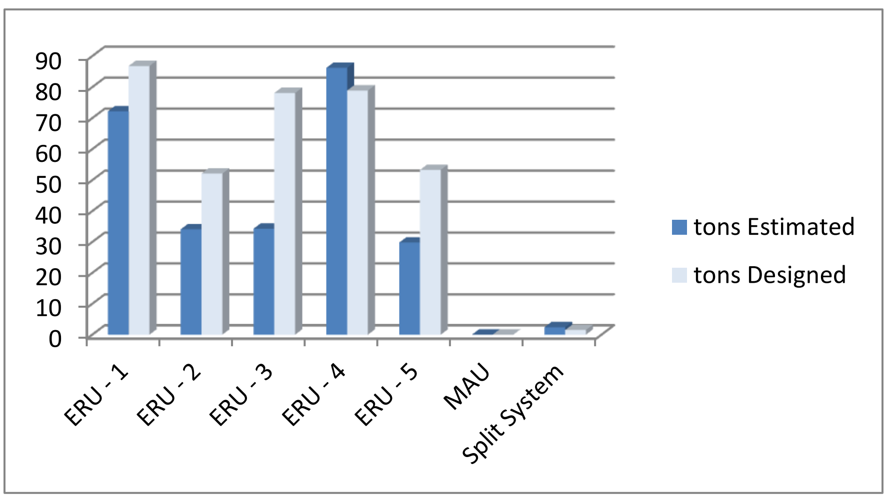


Figure 6 – Estimated tons vs. Designed tons

As you can see, the design conditions are typically higher than the estimated conditions using the TRACE model. This could be due to the assumptions made. It is also possible that not all of the entire building was modeled properly in trace. Some spaces may have been left out which can account for some variance between the designed and estimated loads. The following table shows a difference between designed and estimated conditions.

Table 7 – Building Cooling Estimated vs. Design Conditions

Cooling Comparisons		
	Estimated	Designed
Area (SF)	97368	105000
CFM	90470	119735
tons	259	350.7
CFM/sf	0.929	1.14
CFM/ton	349.3	341.4
sf/ton	375.9	299.4

Table 8 – Building Heating Estimated vs. Design Conditions

Building Design Heating Capacity MBh		
	Estimated	Designed
Totals	3955.5	3350.6

Energy Consumption Distribution Summary

The energy distribution graph below depicts the estimated energy consumption distribution for the Slippery Rock University Student Union. These values seem to be a fairly accurate depiction of the building system. Due to the hot water heat transfer system, the energy cost due to heating and cooling should be relatively low as they are shown. However, it seems that the pumps may actually use more energy than about ½ percent shown below.

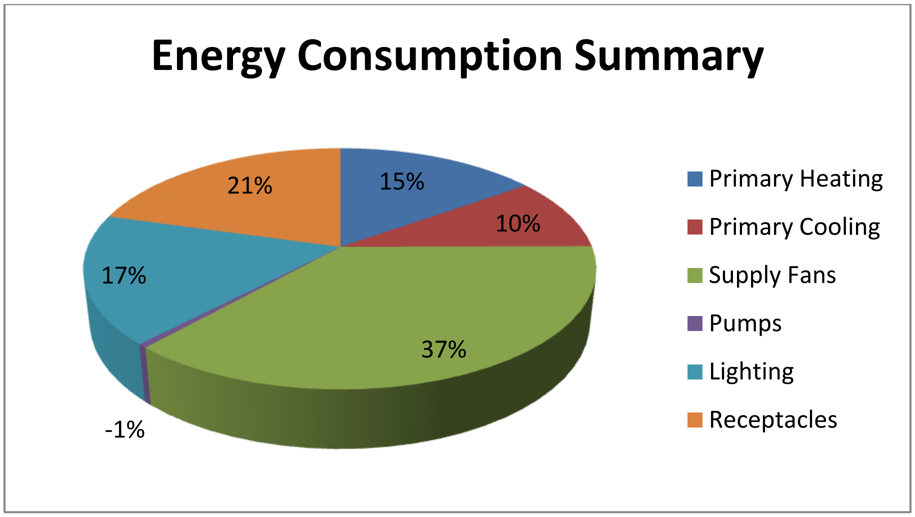


Figure 7 – Energy Consumption Distribution Graph

The remaining systems appear to be reasonable. The building uses highly efficient lighting fixtures, so although they are substantially used throughout the day, the energy consumption remains at a lower rate.

The energy consumption from the receptacles also seems to be correct. The building has many offices, conference rooms, and lounges. They will most likely provide the majority of the receptacle output.

The primary heating and primary cooling are all relatively evenly distributed. The building has spaces that are simultaneously being heated and cooled. The energy transfer from the hot water heat transfer system allows for these loads to be lower because if one system is giving off heat in order to cool a zone, the excess heat is being used at a different zone.

Design Load Estimation

Monthly Consumption

Natural Gas

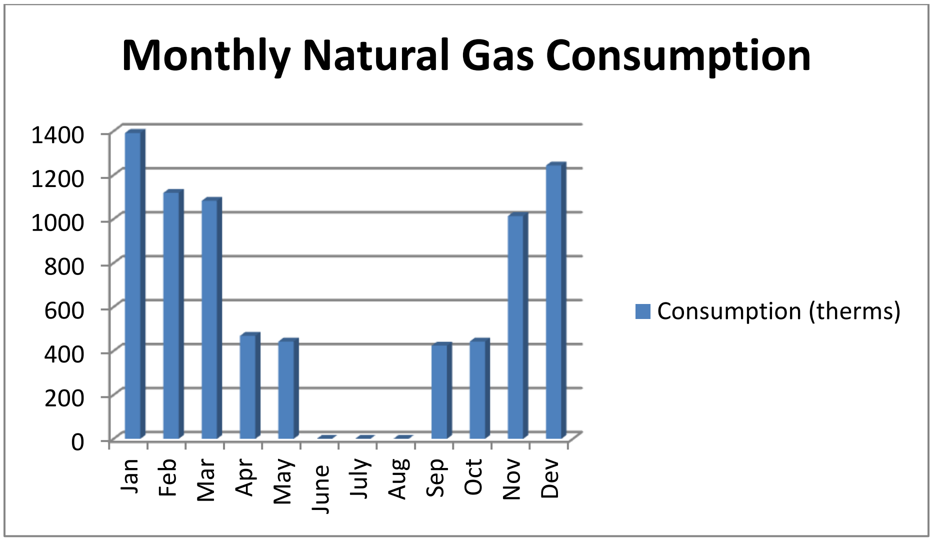


Figure 8 – Monthly Natural Gas Consumption Graph

The figure above shows the monthly natural gas consumption rates throughout the year. As you can see, when heating loads are low enough, the hot water heat transfer system is able to completely satisfy the heating needs of the building. The building does not require any auxiliary heating, therefore uses no natural gas.

Table 9 – On Peak Monthly Natural Gas Consumption Cost Analysis

On Peak Monthly Natural Gas Consumption Cost Analysis			
Month	Consumption (therms)	Price per Therm ($)	Cost ($)
Jan	1392	1.16	1614.72
Feb	1119	1.16	1298.04
Mar	1083	1.16	1256.28
Apr	469	1.16	544.04
May	443	1.16	513.88
June	0	1.16	0
July	0	1.16	0
Aug	0	1.16	0
Sep	424	1.16	491.84
Oct	443	1.16	513.88
Nov	1014	1.16	1176.24
Dev	1244	1.16	1443.04
Total	7631	1.16	8851.96

The cost per therm was found on the website of the U.S. Energy Information Administration website. The cost is equal to 12.01$ per cubic foot. I then converted cubic feet into BTUs, then BTUs into therms to find the cost per therm. I used the consumption in therms from the trace model to accurately find out the total monthly cost of natural gas and finally the total annual cost.

Steam

Table 10 – On Peak Steam Energy Consumption Cost Analysis

On Peak Steam Energy Consumption Cost Analysis			
Month	Consumption	$ per therm	Cost ($)
Jan	894	1.057	944.96
Feb	635	1.057	671.20
Mar	582	1.057	615.17
Apr	286	1.057	302.30
May	126	1.057	133.18
June	120	1.057	126.84
July	118	1.057	124.73
Aug	125	1.057	132.13
Sep	220	1.057	232.54
Oct	274	1.057	289.62
Nov	629	1.057	664.85
Dev	635	1.057	671.20
Total	4644	1.057	4908.71

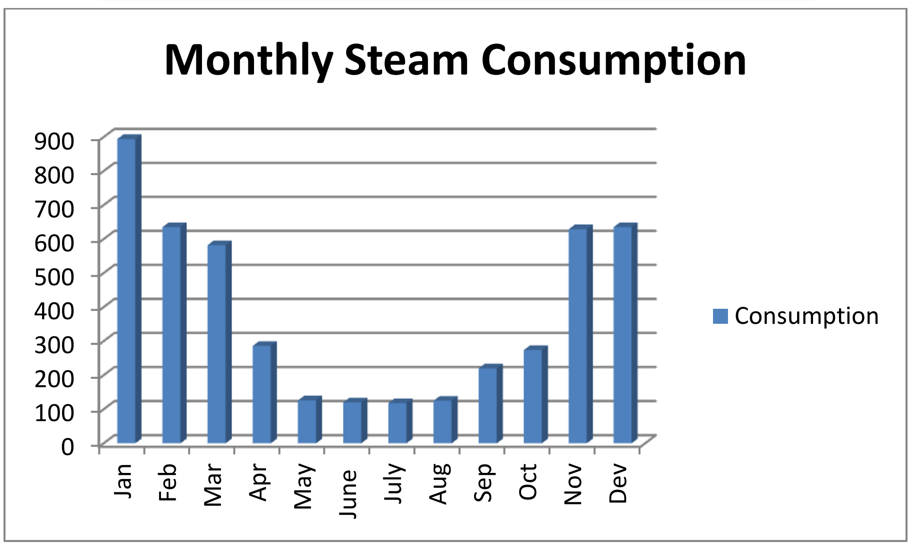


Figure 9 – Monthly Steam Consumption Graph

The steam is provided by the Slippery Rock University Campus Steam Plant. I was able to obtain the cost of steam from the engineer in order to calculate the monthly energy costs. Figure 7 shows that there is not much use for steam in the summer with exception to provide a sufficient amount of hot water.

Electricity

Table 11 – On Peak Monthly Electricity Energy Consumption Cost Analysis

On Peak Monthly Electricity Energy Consumption Cost Analysis									
	Electrcity		Price per kWh		Price per kW		Monthly Cost ($)		Total Monthly Cost ($)
Month	Consumption (kWh)	Demand (kW)	0 - 40,000 kW	> 40,000 kW	0 - 100 kW	> 100 kW	Consumption	Demand	
Jan	102742	289	0.05113	0.04615	7.04	6.05	4940.74	1847.45	6788.19
Feb	94481	293	0.05113	0.04615	7.04	6.05	4559.50	1871.65	6431.15
Mar	107037	281	0.05113	0.04615	7.04	6.05	5138.96	1799.05	6938.01
Apr	110645	332	0.05113	0.04615	7.04	6.05	5305.47	2107.60	7413.07
May	57011	223	0.05113	0.04615	7.04	6.05	2830.26	1448.15	4278.41
June	43703	238	0.05113	0.04615	7.04	6.05	2216.09	1538.90	3754.99
July	49370	241	0.05113	0.04615	7.04	6.05	2477.63	1557.05	4034.68
Aug	42280	229	0.05113	0.04615	7.04	6.05	2150.42	1484.45	3634.87
Sep	141650	496	0.05113	0.04615	7.04	6.05	6736.35	3099.80	9836.15
Oct	128110	387	0.05113	0.04615	7.04	6.05	6111.48	2440.35	8551.83
Nov	99805	277	0.05113	0.04615	7.04	6.05	4805.20	1774.85	6580.05
Dec	39633	102	0.05113	0.04615	7.04	6.05	2028.26	716.10	2744.36
Total	1016467	496	0.05113	0.04615	0.98	0.82	49300.35	21685.40	70985.75

Table 10 shows both the consumption and demand load for electricity both monthly and annually thoughout the year. As shown in the table above, the cost of elecricity was found on the West Penn Power Company website. It provides demand energy charges for the first and second block kilowatts along with the first and second block kilowatt-hour charges for energy consumption. The total monthly costs are accurate due to the scale of the building. They are likely lower than most buildings of similar size due to the high efficient mechanical systems and lighting fixtures.

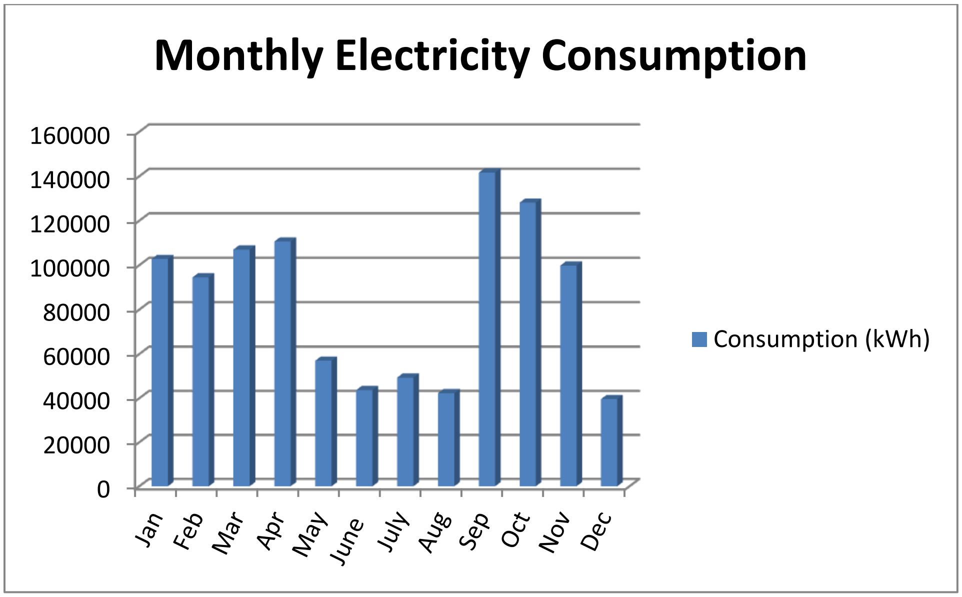


Figure 10 – Monthly Electricity Consumption Graph

Shown in Figure 8, the electricity rates drop dramatically in December, and also during the summer months of May through August. This can be attributed to the fact that the building is part of The Slippery Rock University. There are not as many students at school in the summer compared to rest of the year. The students also are off for winter break in the December shown by the lower electricity rates.

Total Cost Analysis

Table 12 – Total Monthly and Annual Energy Cost

Total Monthly and Annual Energy Cost				
Month	Natural Gas ($)	Electricity ($)	Steam ($)	Total ($)
Jan	1614.72	6788.19	944.96	9347.87
Feb	1298.04	6431.15	671.20	8400.39
Mar	1256.28	6938.01	615.17	8809.46
Apr	544.04	7413.07	302.30	8259.41
May	513.88	4278.41	133.18	4925.47
June	0.00	3754.99	126.84	3881.83
July	0.00	4034.68	124.73	4159.41
Aug	0.00	3634.87	132.12	3766.99
Sep	491.84	9836.15	232.54	10560.53
Oct	513.88	8551.83	289.62	9355.33
Nov	1176.24	6580.05	664.85	8421.14
Dec	1443.04	2744.36	671.20	4858.60
Total	8851.96	70985.75	4908.71	84746.42

Once all of the energy rates were obtained, the next step was to use the amount of energy consumption for each energy source per month to find a monthly rate. Then the monthly rates of natural gas, electricity, and steam were added together to get a total monthly energy cost. The final step was to add all off the months together to get a total annual energy cost. Table 11 shows that during the first month that each semester resumes, energy costs are greatly increased. Each graph follows similar trends. Loads begin to increase around September where they tend to increase until January. They then start to decline until they are low in the summer.

Energy Consumption Summary

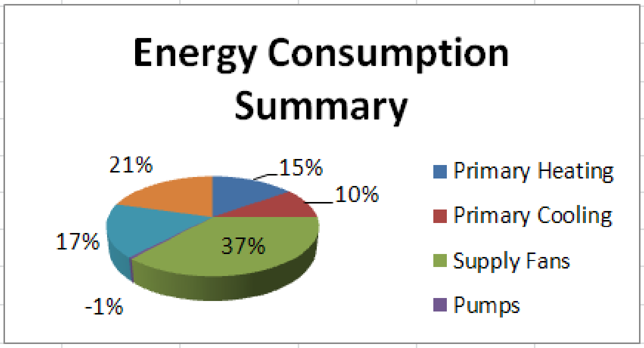


Figure 11 – Fractional Energy Consumption Summary

Table 13 – Fractional Cost of Operation

Energy Cost Breakdown		
Consumer	Annual Energy Cost ($)	Cost/ SF
Primary Heating	12796.71	0.131426
Primary Cooling	8305.15	0.085296
Supply Fans	31101.94	0.319427
Pumps	423.73	0.004352
Lighting	14661.13	0.150574
Receptacles	17457.76	0.179297
Building Total	84746.42	0.870373

Emissions

Table 14 – Total Emissions for Delivered Natural Gas

Total Emission Factors for Delivered Natural Gas				
Pollutant	lb per CF	Therms	Cubic Feet	Amount of Pollutant (lb)
CO_2	1.16E+00	7631	742218	860972.88
NO_X	1.64E-02	7631	742218	12172.38
SO_X	1.22E+00	7631	742218	905505.96
CH_4	7.04E-01	7631	742218	522521.47
N_20	2.35E-04	7631	742218	174.42
CO	1.36E-02	7631	742218	10094.16
Lead	2.41E-07	7631	742218	0.18
Mercury	5.51E-08	7631	742218	0.04
PM10	8.17E-04	7631	742218	606.39
PM- unspecified	1.42E-03	7631	742218	1053.95
Solid waste	1.60E+00	7631	742218	1187548.80

Table 15 – Total Emissions for Delivered Electricity

Total Emission Factors for Delivered Electricity			
Pollutant	lb per kWh	Consumption	Amounts of pollutant (lb)
CO_2	1.74E+00	1016467	1768652.58
NO_X	3.00E-03	1016467	3049.40
SO_X	8.57E-03	1016467	8711.12
CH_4	3.59E-03	1016467	3649.12
N_20	3.87E-05	1016467	39.34
CO	8.45E-04	1016467	858.91
Lead	1.39E-07	1016467	0.14
Mercury	3.36E-08	1016467	0.03
PM10	9.26E-05	1016467	94.12
Solid waste	2.05E-01	1016467	208375.74

Table 13 and Table 14 represent the amount of pollutants that are created through the energy distributed to the Slippery Rock University Student Union by the power plant generation. Therms were converted into cubic feet in order to use the values given in Western area of the Regional Grid Emission Factors 2007 Guide.

Summary

Overall, the building energy analysis was successful. The majority of the results appear to be reasonable to the actual design conditions with variation in some cases. The variances can be attributed to the assumptions made in the model. It appears that the building has a mechanical system that is considerably oversized in some zones. This could potentially be an issue that could be improved upon later in the senior capstone project.

References

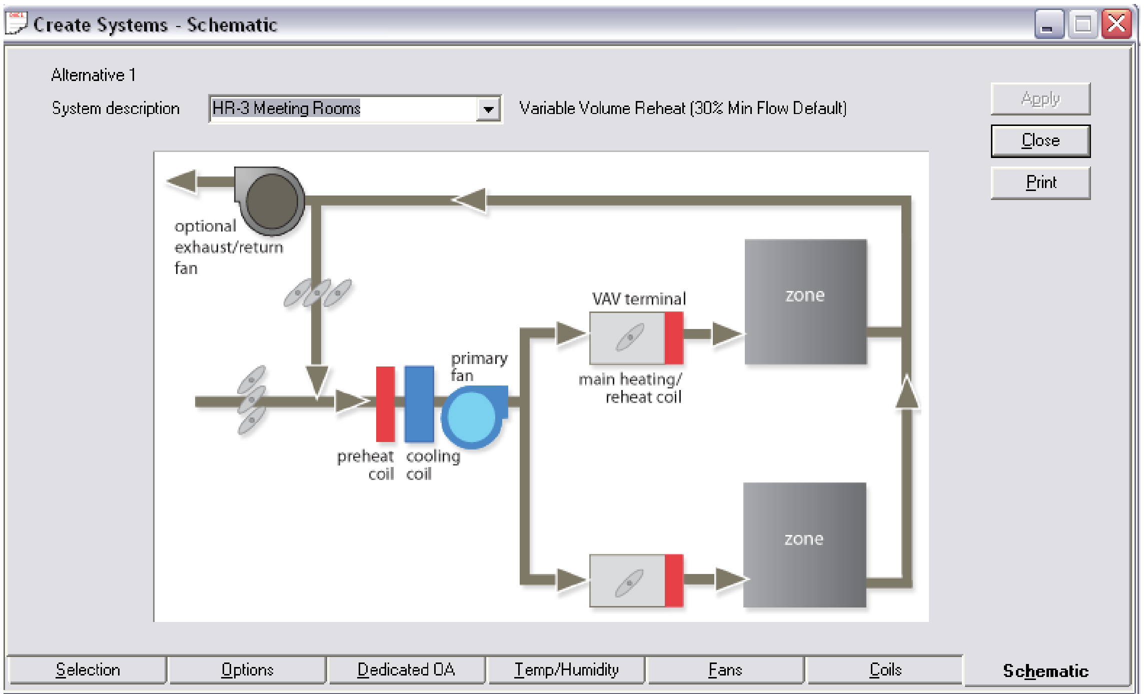
- Western area of the Regional Grid Emission Factors 2007 Guide
- ASHRAE Handbook of Fundamentals 2009
- http://www.paelectricrates.com/
- http://www.eia.doe.gov/oil_gas/natural_gas/info_glance/natural_gas.html
- http://www.eia.doe.gov/kids/energy.cfm?page=about_energy_conversion_calculator-basics
- CJL Engineering Mechanical Drawings and documents
- DRS Architects Architectural Drawings and documents
- Trane TRACE 700

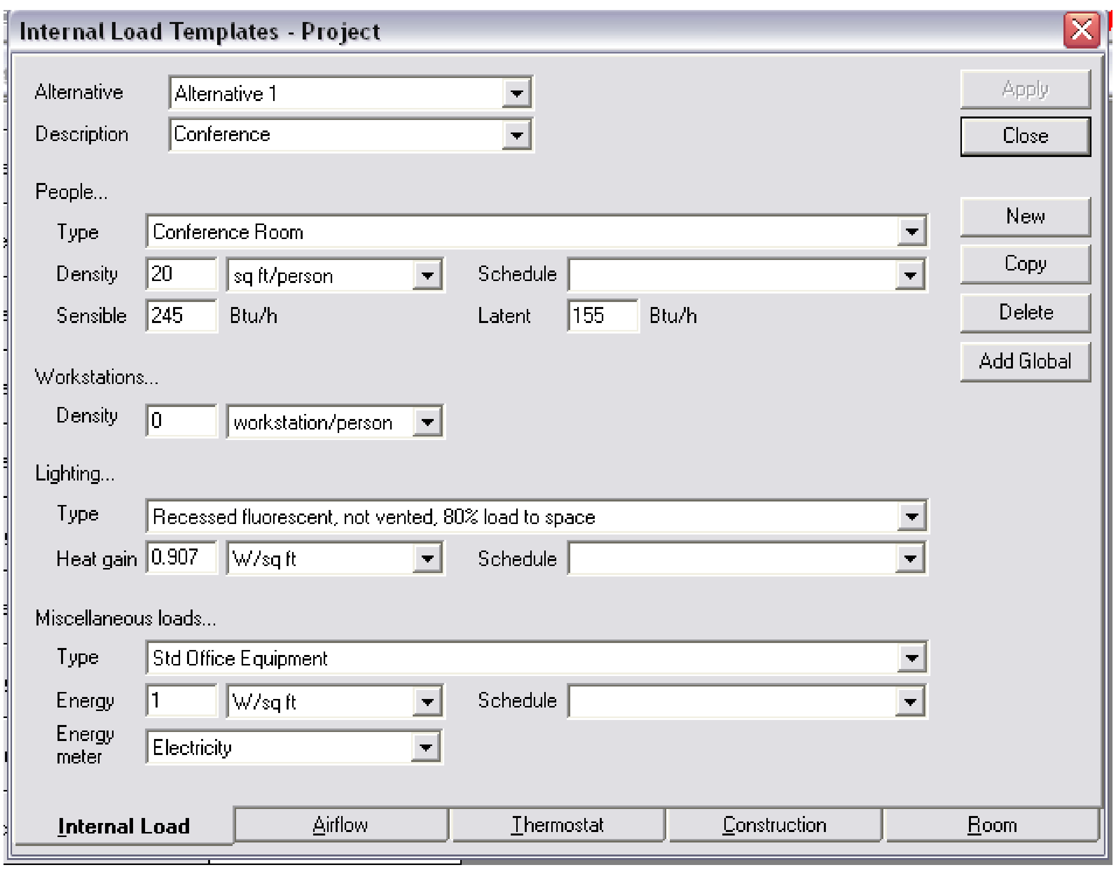
Appendix A – List of Tables and Figures

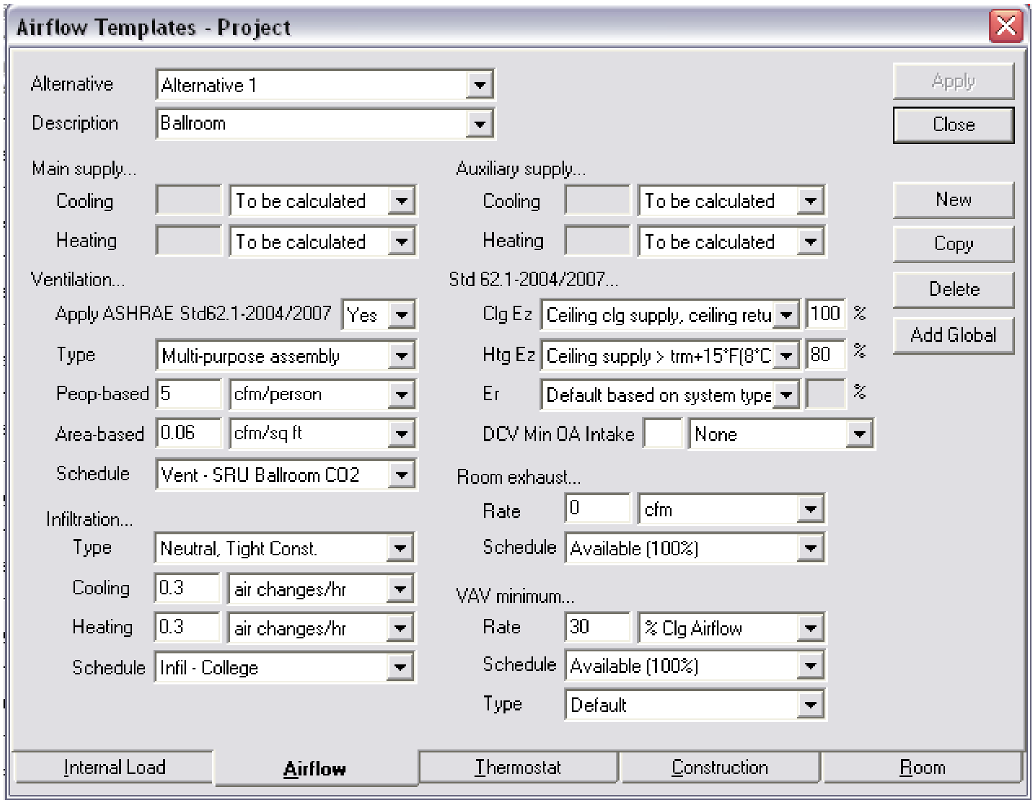
Appendix B – Supplementary Tables

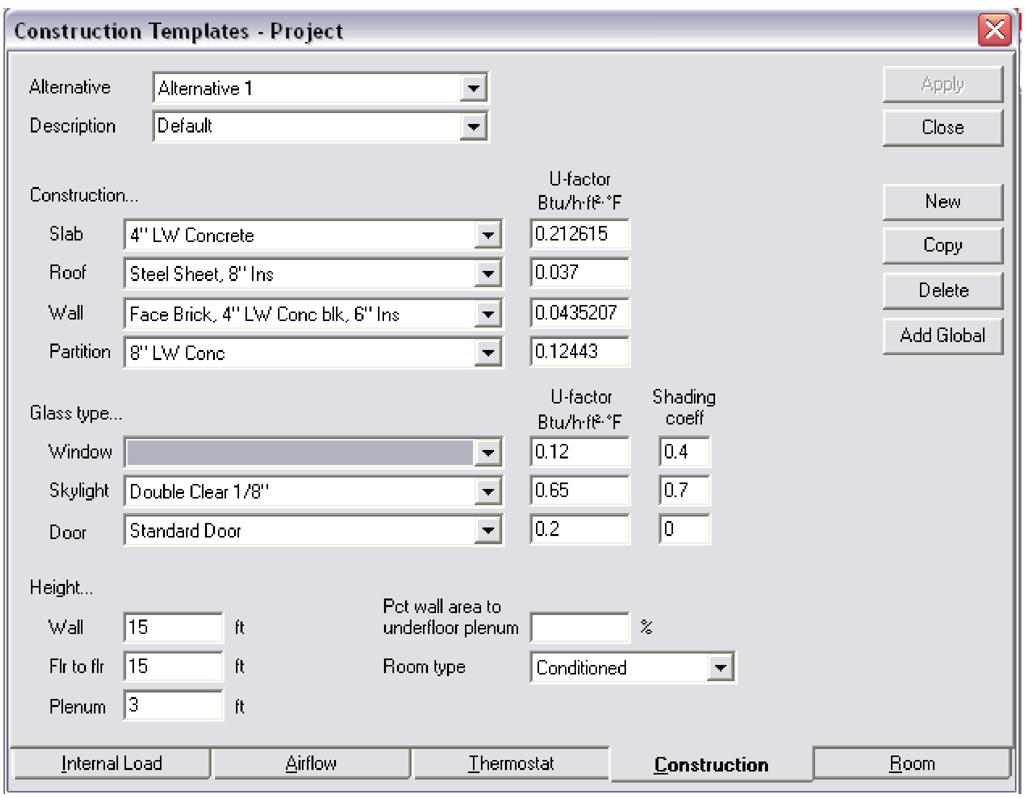
Room #	Space Name	Area	Room #	Space Name	Area	Room #	Space Name	Area
101	East Entry	220	113	Office	107	240	Office	83
102	Corridor	2518	114	Office	113	241	Office	83
150	Bookstore	7277	124	Coop Act	309	260	Resource Area	233
149	Dressing room	38	128	Mech Room	470	261	Student Orgs	232
140	Storage	4828	122	Storage	61	237	Student Orgs	250
142	Accounts	115	125	Dir Coop	93	238	Student Orgs	250
144	Store manager	103	126	Stor/Server	81	239	Student Orgs	250
146	Employee Lounge	211	109	Womens Toilet	211	236	Student Lounge	479
145	IT/Copy	130	110	Mens Toilet	211	266	Paint	81
141	Utility	40	130	IT	125	243	Student Orgs	240
135	Corridor	361	129	Mech Room	1391	244	Student Orgs	240
138	UPS	1916	127	Ftn Pump Rm	265	245	Student Orgs	240
137	Café Storage	302	248	Office	172	233	Corridor	212
136	Café	1255	254	Office	87	248	Office	55
104	Entry Lobby	1717	255	Office	87	222	Office	56
103	Entry Vestibule	275	256	Womens Center	413	220	Lockers	327
106	Corridor	713	253	Safe Room	91	221	Lockers	327
139	Bank	782	257	Office	93	203	Cultural Lounge	836
118	Conference	227	258	Office	93	235	Commuter Pantry	93
119	Directory	112	259	Office	93	234	Loading Storage	597
120	VP assistant	112	262	Office	92	202	Small Lounge	2487
121	Univ UN Oper	938	263	Office	92	233	Corridor	643
117	Work/Storage	157	264	Office	92	202B	Upper Lobby	1591
116	Building Manager	109	242	Office	84	229	Womens Toilet	355

Room #	Space Name	Area	Room #	Space Name	Area	Room #	Space Name	Area
228	Mens Toilet	258	327	Pantry	127	108	Utility	35
218	Corridor	741	325	Storage	275	148	Vestibule	76
223	Electical	149	324	Corridor	525	131	Electrical	198
224	IT	149	323	Toilet	55	128	Mechanical Corridor	470
216	Trash	267	320	Womens Toilet	454	104	Storage	81
215	Dry Storage	184	319	Mens Toilet	340	149	Storage	38
225	Storage	474	315	Electrical	142	231	Utility	31
219	Storage	550	316	IT	142	202	Storage	106
209	Office	96	314	Green Room	142	333	Small Meeting	486
207	Kitchen	2385	318	Coat storage	325	321	Custodial	25
206	Servery	3551	317	Ballroom Support	797	317	Utility	28
205	West Dining	6314	307	Staging Corridor	1610	314	Toilet	125
335A	Electical	194	312	Catering Kitchen	1042	311	Storage	140
335B	IT	194	309	Storage/AV	110	313	Catering Storage	380
334	Small Meeting	435	308	Ballroom Support	555	1ST3	Stairwell 3	350
337	Medium Meeting	720	306	Ballroom	7400	1ST4	Stairwell 4	253
339	Large Meeting	1237	304	Prefunction	2766	2ST3	Stairwell 3	408
340	Medium Meeting	698	204	Fireplace Lounge	1349	2ST4	Stairwell 4	647
328	Circulation	1440	326	Tech	119	2ST5	Stairwell 5	589
330	Large Meeting	954	147	ookstore Textbool	400	2ST6	Stairwell 6	280
331	Large Meeting	954	247	Conference	201	3ST3	Stairwell 3	418
341	Storage	435	236	Work Area	2786	3ST4	Stairwell 4	652
303	Theater/Multipurpose	2803	143	ccounts Receivabl	110	3ST5	Stairwell 5	583
301	Circulation/Lobby	3360	133	Corridor	1416	3ST6	Stairwell 6	286
						TOTAL		97368


Create Systems - Schematic
Alternative 1
System description
HR-3 Meeting Rooms
Variable Volume Reheat (30% Min Flow Default)
Apply
Close
Print
optional exhaust/return fan
VAV terminal
zone
primary fan
main heating/ reheat coil
preheat coil
cooling coil
zone
Selection
Options
Dedicated OA
Temp/Humidity
Fans
Coils
Schematic


Internal Load Templates - Project
Alternative
Alternative 1
Description
Conference
Apply
Close
People...
Type
Conference Room
New
Density
20
sq ft/person
Schedule
Copy
Sensible
245
Btu/h
Latent
155
Btu/h
Delete
Add Global
Workstations...
Density
0
workstation/person
Lighting...
Type
Recessed fluorescent, not vented, 80% load to space
Heat gain
0.907
W/sq ft
Schedule
Miscellaneous loads...
Type
Std Office Equipment
Energy
1
W/sq ft
Schedule
Energy meter
Electricity
Internal Load
Airflow
Thermostat
Construction
Room


Airflow Templates - Project
Alternative
Alternative 1
Description
Ballroom
Apply
Close
New
Copy
Delete
Add Global
Main supply...
Cooling
To be calculated
Heating
To be calculated
Auxiliary supply...
Cooling
To be calculated
Heating
To be calculated
Ventilation...
Apply ASHRAE Std62.1-2004/2007
Yes
Type
Multi-purpose assembly
Peop-based
5
cfm/person
Area-based
0.06
cfm/sq ft
Schedule
Vent - SRU Ballroom CO2
Std 62.1-2004/2007...
Clg Ez
Ceiling clg supply, ceiling retu
100
%
Htg Ez
Ceiling supply > rm+15°F(8°C
80
%
Er
Default based on system type
%
DCV Min OA Intake
None
Room exhaust...
Rate
0
cfm
Schedule
Available (100%)
Infiltration...
Type
Neutral, Tight Const.
Cooling
0.3
air changes/hr
Heating
0.3
air changes/hr
Schedule
Infil - College
VAV minimum...
Rate
30
% Clg Airflow
Schedule
Available (100%)
Type
Default
Internal Load
Airflow
Thermostat
Construction
Room


Construction Templates - Project
Alternative
Alternative 1
Description
Default
Apply
Close
New
Copy
Delete
Add Global
Construction...
U-factor
Btu/h·ft²·°F
Slab
4" LW Concrete
0.212615
Roof
Steel Sheet, 8" Ins
0.037
Wall
Face Brick, 4" LW Conc blk, 6" Ins
0.0435207
Partition
8" LW Conc
0.12443
Glass type...
U-factor
Btu/h·ft²·°F
Shading
coeff
Window
0.12
0.4
Skylight
Double Clear 1/8"
0.65
0.7
Door
Standard Door
0.2
0
Height...
Wall
15
ft
Flr to flr
15
ft
Plenum
3
ft
Pct wall area to
underfloor plenum
%
Room type
Conditioned
Internal Load
Airflow
Thermostat
Construction
Room