Technical Assignment II

Building and Plant Energy Analysis

The Hershey Press Building
Hershey, PA

Alyssa Adams | Mechanical Option | October 24, 2008 | Dr. William Bahnfleth

Table of Contents

Executive Summary

The Hershey Press Building, originally built in 1915, has been renovated to accommodate four tenants including Hershey Entertainment and Resorts offices, Houlihan's restaurant, Jack Gaughen Realty offices, and Devon Seafood Grill restaurant.

The mechanical system for the Hershey Press Building comprises of three natural gas boilers, a closed-loop fluid cooler in conjunction with a cooling tower, two roof-mounted energy recovery ventilators, two make-up air units, four kitchen grease exhausts, and ninety-four water source heat pumps (WSHP). The water source heat pumps are ceiling mounted, serving the rooms and zones of all three floors. Connected in series, a water source heat pump loop serves the heat pumps, where each WSHP evaporator will extract or supplement the loop with heat. This loop will run through a heat exchanger, where it will replenish the heat from a boiler loop or relinquish heat onto a fluid cooler loop. The kitchen exhausts will exhaust the two kitchen grilles while the two make-up air units will relieve the kitchens with relief air.

For this technical assignment, the building and plant energy will be analyzed. This includes the mechanical equipment, the lighting and miscellaneous equipment that provides thermal load to the space.

Trace, energy simulation software, will simulate the building's energy performance as well as compute air flow rates required for a well conditioned space. By providing various building information components, and the characteristics of these components, the building load and air flow summary can be generated. With the use of schedules and the specification of mechanical equipment, in conjunction with the corresponding heating and cooling plants, the quantity of conditioning the building and the energy consumption can be calculated.

The room/zone load, as well as ventilation and supply air flow rates, can then be compared to the original design documents. This information will show the simularities and difference between the Trace model and the designed system.

The energy consumption results will provide a detailed summary of the large energy consumers of the building. With the consumption and utility rates, the operating electricity, gas, and water costs can be determined on a monthly and annual basis. Computing the individual utility consumptions, an accurate annual building operating cost can be determined.

From the operating cost and the building floor area, the cooling cost per square foot can be derived in order to compare the building's energy performance to other similar buildings.

Overall, the building's energy performance and operating costs will provide the owner with a peak energy consumption values and annual budgetary building operation costs. The owner can use this information to find building energy reduction areas, in which overall savings will occurs.

Design Load Estimation Input

In order to accurately model the energy performance and cost for the Hershey Press Building, energy modeling software must be used. Trace 700, modeling software developed by Trane, was used for the simulation. The first step is to model the building's individual rooms and zones.

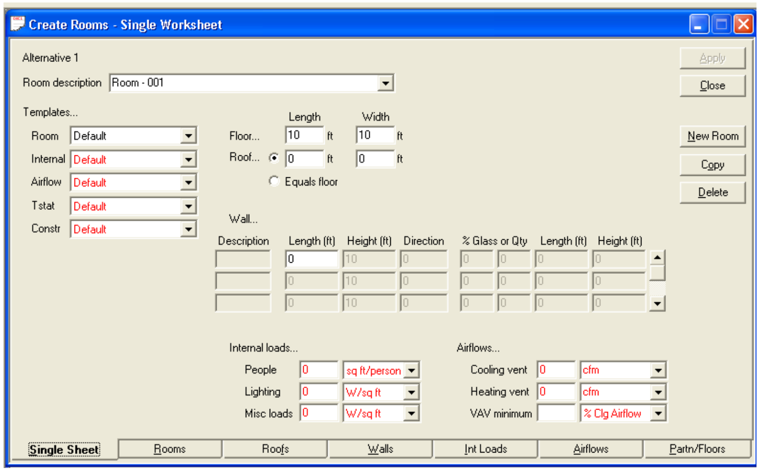


Figure 2-1: Create Rooms Input Module for Trace

Several key parameters were used to each room and zone's thermal loads and energy usage accurately. Each room or zone in the building can be simulated using the "Create Rooms – Single Worksheet" interface, seen in Figure 2-1. The information that was inputted in the module and where that information was found is as follows:

- Room Area – The floor area of each room or zone taken from the architectural drawings.
- Roof Area – The area of the roof that was above each room/zone. Used for 3rd floor.
- Wall Area – The area of the exterior wall that surrounded the room or zone. Includes the length, height, and direction the wall faces. (0 degrees for North, 90 for East, 180 for South and 270 degrees for West). The Hershey Press Building isn't aligned to the cardinal directions, so the values used were 75, 165, 255, and 345 degrees. Glass, or glazing, can also be added to the wall by specifying the area of the window or the percentage of the wall that is glass.
- Internal Loads - The internal loads, such as people, lighting and miscellaneous loads can be added to the model. The people, taken from the design documents, are the number of occupants that typically fill the space at fully occupancy. The lighting load specifies the amount of wattage or wattage per square foot for each space or zone. The miscellaneous loads are any loads in the space that will provide a thermal output, such as computers, copiers, grilles, and other common kitchen and office equipment that adds to the spatial cooling load.
- Airflows – The amount of ventilation air required for each space or zone can be entered directly into the program. The minimum VAV volumetric air flow rate can also be entered.

Modifications for each key parameter are necessary. These individual characteristics that affect the performance of the parameter must match the building's characteristics. The values used for these characteristics came from the original building models. See Figure 2-2 for the parameters characteristics that can be adjusted using Trace.

Parameter	Customizable Performance Affecting Characteristics
Rooms	Floor to floor, plenum and above the ground height. Design cooling and heating design bulb, as well as relative humidity. Thermostat cooling and heating drift points. Sensors, including thermostat, CO2 sensor and humidistat, and their locations. Floor construction, carpeting, acoustical ceiling resistance, and the room mass/average time lag.
Roofs	Roof construction, including roof u-factor, pitch and direction the roof faces. Roof skylight option including the glass u-factor, shading coefficient width, length and quantity. Shading option if shaded from nearby buildings, etc.
Walls	Wall construction, including the u-factor, tilt of wall, and the direction the wall faces. Glass in the wall, including windows, can also by customized, by specifying the type of glass, the glass u-factor, the shading coefficient, as well as the length, height, and quantity of the windows. Shading for the wall, including internal and external measures, can also be specified.
Internal Loads	People, Lights, and Miscellaneous Loads can be edited to match the room/zone. For the People category, each person's activity level can be modified as well as the sensible and latent load given off for each person. For the Lights, individual types of fixtures including recessed fluorescents and incandescents may be specified as well as the heat gain to space, described in watts/square foot. For the Miscellaneous Loads category, the amount of energy given off as well as where the energy is coming from (gas, electricity, etc) can be specified, also in a watts/square foot basis.
Air Flows	Main supply ventilation for heating and cooling either calculated or input directly. It is important to use the OA ventilation rates from the original design. Infiltration types, cool, and heating for the air changes. Auxiliary supply option for heating and cooling. Room exhausts rate and the schedule for the air changes. VAV minimum airflows as well as the type and the schedule.
Partition/Floors	Partitions can be entered, as well as their length, height, construction u-factor, and the adjacent rooms it will face. Floor constriction, area, perimeter, u-factor, loss coefficient, and type can also be customized.

Figure 2-2: Trace Building Inputs that Can Be Customized for Zone/Room Parameters

The Trace model included 189 rooms and zones. The division was necessary in order to model each room and zone as accurately as possible. The loads for each of the rooms were calculated, which gave the designers the ability to size and suggest conditioning equipment and plants. See Appendix A for various parameter and parameter charactertic Trace inputs.

The Trace model also needs an input for the equipment used within the building. For equipment, the Hershey Press Building has ninety-four water source heat pumps, two energy recovery ventilators, two make-up air units, seven kitchen and roof exhausts, and twelve radiant heaters. This was then divided into four conditioning equipment systems:

- System 1 – First Floor Water Source Heat Pumps, including the air-to-air energy recovery (ERV) option with main circulating fan, system exhaust fan, and ventilation fan.
- System 2 – Second and Third Floor Water Source Heat Pumps, including the air-to-air energy recovery (ERV) option with the main circulating fan, system exhaust fan, and ventilation fan.
- System 3 – Miscellaneous Equipment, which included the energy usage of the make-up air units and roof and kitchen hood exhausts.
- System 4 – Radiant Heaters, which include the electrical resistance of the heating months, November – May.

Trace also needs information for the Plants, the supplier of energy for the pieces of equipment. The plant, for the Hershey Press Building, included the three gas-fired boilers, one fluid cooler coupled with a cooling tower, as well as two pumps, one primary and one auxiliary. There is a two-pipe heat rejection/absorption loop that circulates the building, utilizing only one set of pumps. The way in which it was modeled in Trace is as follows:

- Cooling Plant 1 – Water Source Heat pumps with cooling tower, controls, and primary chilled water pump.
- Heating Plant 1 – Gas Fired Boiler including a back draft fan and control panels with interlocks
- Heating Plant 2 – Electric Resistance for the radiant heaters

The lights, miscellaneous loads, and the energy recovery wheel motor were all considered to utilize electrical power, and were added into the monthly equipment consumptions. For the fans and pumps, it was necessary to convert the horsepower of the motors into kilowatts, in order to add them into Trace. Trace was then able to model all of the equipment based on the full load or partial load of the system, depending on the season, and the electrical or loop draw it would require. It was also important to include the static pressure of the fans to accurately model the motor electrical usage.

Schedules were used to simulate different parameters. These parameters include the amount of people in the space per hour, the percentage of lights being used per hour, and the amount of ventilation required per hour for a restaurant and low rise office space. See Appendix A for the graphs of these three schedules. The accuracy of the model is increased when it simulates the energy load based on the peaks of the building's energy usages. The trends of an office and a restaurant differ depending on the hours occupied, the peak ventilation hours, as well as the light output required at different hours of the day.

Trace also uses the design indoor and outdoor air conditions based on ASHRAE's Handbook of Fundamentals 2005. These values were the default values used for the analysis and based on the building location. The closest town to model after Hershey is Harrisburg, PA, which is approximately 18 miles from Hershey. The Trace model is now ready to estimate the design cooling load and design heating load based on the information found in the design documents.

Design Load Estimation Output

After running and calculating the results, Trace computed the load and ventilation rates. This included the cooling area per ton, the total supply air flow rate per area and the ventilation supply flow rate per area. To get a basis of the accuracy of these results, it is necessary to compare the Trace results to original findings.

The Hershey Press Building was constructed in one major renovation and three tenant fit-out designs. It became necessary to sum all four design load and ventilation rates from the original four designs in order to make a comparison from the newest findings.

Original Design Calculations			
	Cooling Load ft^2/ton cooling	Supply Air cfm/ft^2 supply	Vent Air cfm/ft^2 vent
HE&R Offices	312.02	1.91	0.21
Houlihans	159.60	3.43	0.84
Jack Gaughen	275.73	1.91	0.37
Devon Seafood	239.20	2.00	0.39
Total	269.82	2.09	0.32

Figure 2-3: Load and Ventilation Calculations for the Original Design

In order to find the total, all space areas were added together as well as the sum of all 4 tons of cooling. Once the areas and tons were summed, the quotient of both values was taken to find the total area per ton of cooling was found for the original design. Similarly, the supply and ventilation flow rate per area were also found using the same method. See Figure 2-3 for the original design findings. These design documented values were than compared to Trace model for the computed load.

Entire Building Trace Calculations			
	Cooling Load ft^2/ton cooling	Supply Air cfm/ft^2 supply	Vent Air cfm/ft^2 vent
Original Total	269.82	2.09	0.32
Trace Model	303.05	1.93	0.30

Figure 2-4: Load and Ventilation Calculations Comparison of The Original Design and Trace Model

By comparing the computed design and the original design, a few observations are made. The most obvious is that the original design and the Trace model are not the same. The Trace model, which was designed to be exact replica of the original design, seems to depict an inaccurate representation.

The reason for this is two-fold. The ventilation calculations used in the original design were over-estimated for the first three phases and then underestimated in the final phase, in accordance with the

International Mechanical Code standards. However, the ventilation rates were permissible by the ASHRAE Standard 62.1-2007 standards, and thus became the new basis of their ventilation design. Because of the change of ventilation standards during the fourth phase, the four tenants didn't have uniform ventilation calculations worked into their original designs compared to what was finally installed. The Trace model ventilation values reflect that of the final design, thus explaining the subtle difference in ventilation per area for the original design and Trace model.

The second reason for the difference in the supply flow rate per area and the area per ton is due to the different heat pump sizing methods for the four designs, compared to the Trace design. The first four calculations used Trace to model the heat pump sizing, however, added the ventilation air in separately. See Figure 2-5 for an example of this calculation. The Trace design included the ventilation rates in the load calculation, therefore, sizing the equipment and air velocities required differently. It was important to design the Trace model in this way, since the conditioning of the outside air through the energy recovery ventilator's enthalpy wheel needed to be modeled towards the total energy calculation.

Heat Pump Calculations				
Total Vent Load	=	4.45	*Vent Rate	*(4.7)
Total Trace Load	=	Trace Total Load (in BTUs)		
Total Design Load	=	Total Vent Load + Total Trace Load		
Sensible Vent Load	=	1.08	*Vent Rate	*(80-72)
Sensible Trace Load	=	Trace Sensible Load (in BTUs)		
Sensible Design Load	=	Sensible Vent Load + Sensible Trace Load		

Figure 2-5: Original Design Heat Pump Sizing Calculations

Another observation found when comparing the original design to the Trace model is values compared to one another. The first value, area per ton of cooling, shows that the Trace model is taking a larger area per ton than that of the original design. This shows the original design was more conservative through the four phases of design than the Trace model's calculation for the entire building. In the same regards, the supply and ventilation flow rates per area are much less in the Trace model as well.

It is important to remember that the original design and the final design, the design in which the Trace model reflects, are different. While the reasons for this may be complicated, it however is not unusual for this to occur. What is important is that our values are similar, and it provides a good "check" of the Trace outputted values in order to be confident an accurate model exists.

Annual Energy Consumption

Trace is not only able to calculate load and ventilation rates; it can also calculate annual energy consumption. Using the same ventilation rates, internal generation rates, and envelope values, Trace was able to estimate the energy consumption required to treat the internal building load found in the "Design Load Estimation Output" section.

While Trace determines the equipment performance characteristics at different times of the year, including the peak hours and days, the equipment capacity and horsepower is specified by the user. The full and partial loads of the design are configured by the program, simulating seasonal energy usages according to lights, occupancy, and ventilation schedules as well as inside and outside space temperatures. While many other variables are included in the final energy design, the Trace model's ability to simulate annual energy consumption is fairly accurate.

According to the energy analysis results, the Hershey Press Building consumes 2,014,881 kWh of energy annually. The breakdown of the energy consumption summary can be found in Figure 2-6. You will notice that the receptacle conditioning load has the highest amount of energy consumption. This is due to two full-service restaurant kitchens that have a substantial conditioning load that needs to be met. The space cooling and lighting are also large energy consumers, however, this is typical for a building of this occupancy and size.

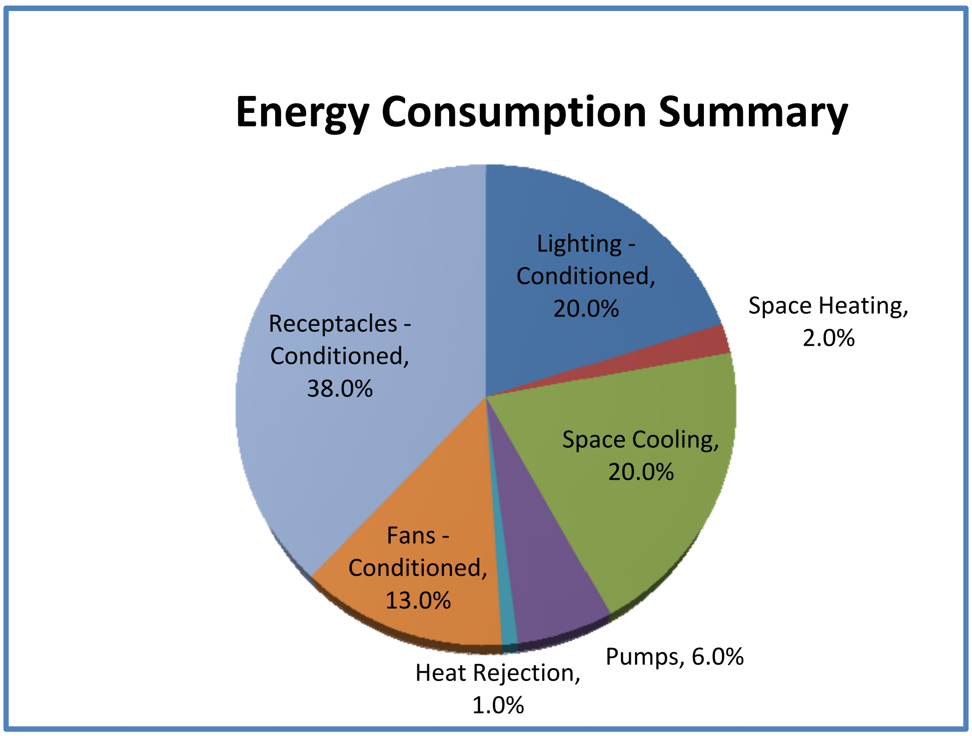


Figure 2-5: Energy Consumption Summary Pie Chart

The monthly energy usage of the Hershey Press building can also be determined. As seen in Figure 2-6, the summer months require the most energy usage while the winter moths seem to maintain a steady energy average. February seems to be the month of the least amount of energy consumption, while this observation is categorically untrue. A possible reason for the lower average could have to do with the lesser amount of days in the month leading to lower energy use. The summer peaks in energy consumption can be explained by the cooling tower consuming more energy to extract heat from the water source heat pump loop. Also, since the space cooling is the second largest energy consumer, it becomes apparent that the cooling season will have higher energy consumption rates.

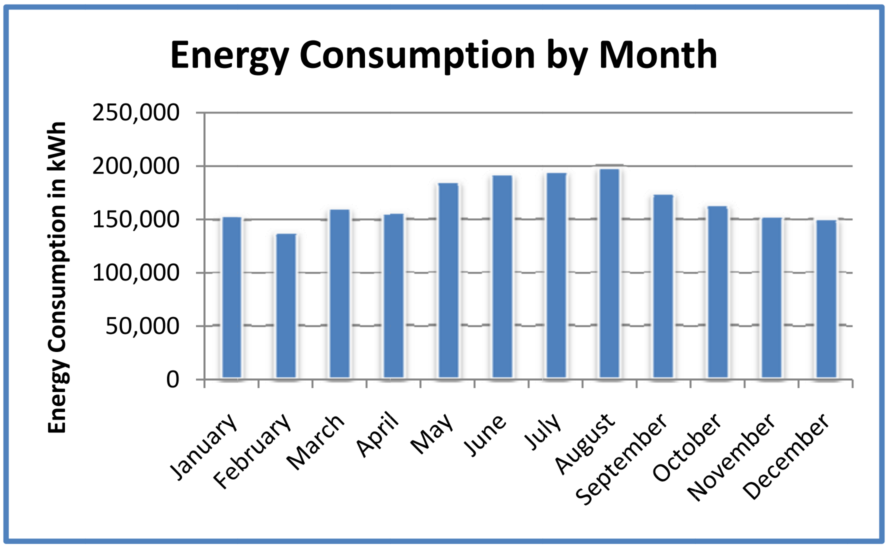


Figure 2-6: Energy Consumption by Month Graph

While a comparison to the original design's energy analysis would allow for more certainty in the model, an original energy analysis was never performed. After interviewing the original design engineer, Matthew Tressler, it became clear that an energy analysis was never a priority. Since the building's design and construction has been a continual process since 2005, the design was never finalized to merit an energy model to be constructed, since the energy model would become obsolete once the next tenant fit-out design was complete. From the original renovation to the final tenant fit-out design recently completed this summer, the mechanical design is finally in a permanent state. Both the design team and the building owners are eager to have a final energy analysis modeled.

Annual Operating Costs

With the annual energy consumption values, an annual operating cost for the building can be developed. This monthly cost analysis can be used by the owner to estimate a building operations budget.

The electricity consumption, as seen in the "Annual Energy Consumption" section, is 2,014,881 kWh per year. This value broken down by month, along with the on-peak kW demand, can be used to estimate a monthly bill. The Hershey Press Building receives its electrical service through PP&L. Since the building is a three-phase building, it utilizes PPL's GS-3 rate scale to calculate its monthly's charges. Using the 2008 calculation form, found in Appendix C, the monthly cost for electric consumption can be closely estimated. The form in Appendix C represents January's charges.

The gas and water can also be estimated by finding the monthly average monthly costs per thousand cubic feet of gas (MCF) and per monthly average cost per gallon of water. The reason for the deviations of cost per months is due to incentives and discounts established by the owner and utilities.

The total consumption and cost for all three utilities, including electricity, gas and water, can be found in Figure 2-7. The totals on the right vertical axis represent the total consumption, rate, and cost for each utility with the exception of electricity, which shows the peak demand kW, the consumed kWh and the total bill cost, taken from the GS3 schedule. The totals on the lower horizontal axis represent the total cost for all three utilities combined. The lower most right cell, hi-lighted in yellow, represents the annual cost of all three utilities. The Hershey Press Building will pay a quarter billion dollars in building operating costs in 2008.

Hershey Press Building Annual Energy Consumption and Operating Costs													
Electricity													
	January	February	March	April	May	June	July	August	September	October	November	December	**Total**
Demand kW	415	429	458	490	530	554	565	556	529	487	457	417	565
Cons. kWh	153,208	138,263	160,194	155,582	184,986	191,372	193,999	198,192	173,681	163,491	151,818	150,095	2,014,881
Cost	$13,729.75	$13,072.06	$14,657.02	$14,800.35	$16,939.37	$17,595.50	$17,879.51	$18,000.57	$16,296.87	$15,203.56	$14,177.74	$13,581.29	$185,933.57
Gas													
	January	February	March	April	May	June	July	August	September	October	November	December	**Total**
MCF	382.9	466.7	361.0	285.2	247.0	253.0	250.7	292.4	353.0	401.0	451.0	496.8	4240.7
$/MCF	10.2760	10.6610	10.6610	10.6610	12.4950	12.4950	12.4950	12.4950	10.6610	10.6610	10.6610	10.2760	12.4950
Cost	$3,934.68	$4,975.49	$3,848.62	$3,040.52	$3,086.27	$3,161.24	$3,132.50	$3,653.54	$3,763.33	$4,275.06	$4,808.11	$5,105.12	$46,784.46
Water													
	January	February	March	April	May	June	July	August	September	October	November	December	**Total**
Gallons	183,000	188,000	197,000	227,500	239,000	318,500	341,000	301,000	286,000	263,000	241,000	221,500	3006500.0
$/Gallon	0.0069	0.0068	0.0069	0.0066	0.0065	0.0062	0.0062	0.0063	0.0063	0.0062	0.0065	0.0066	0.0069
Cost	$1,257.01	$1,283.11	$1,355.32	$1,495.96	$1,556.25	$1,985.40	$2,104.10	$1,893.09	$1,801.80	$1,630.60	$1,566.50	$1,457.94	$19,387.08
Total Cost	$18,921.44	$19,330.66	$19,860.96	$19,336.83	$21,581.88	$22,742.13	$23,116.11	$23,547.20	$21,862.00	$21,109.22	$20,552.35	$20,144.35	**$252,105.12**

Figure 2-7: Energy Consumption and Cost per Month

A better representation of this data can be found on the column chart in Figure 2-8. The bar graph shows the cost and consumption of the three utilities. The green bar represents water costs, the red bar represents gas costs, and the blue bar represents electricity costs for each month. Similar to the energy usage by month, Figure 2-6: Energy Consumption by month, Figure 2-8 shows the peak costs occurring during the summer months, when the space cooling peaks.

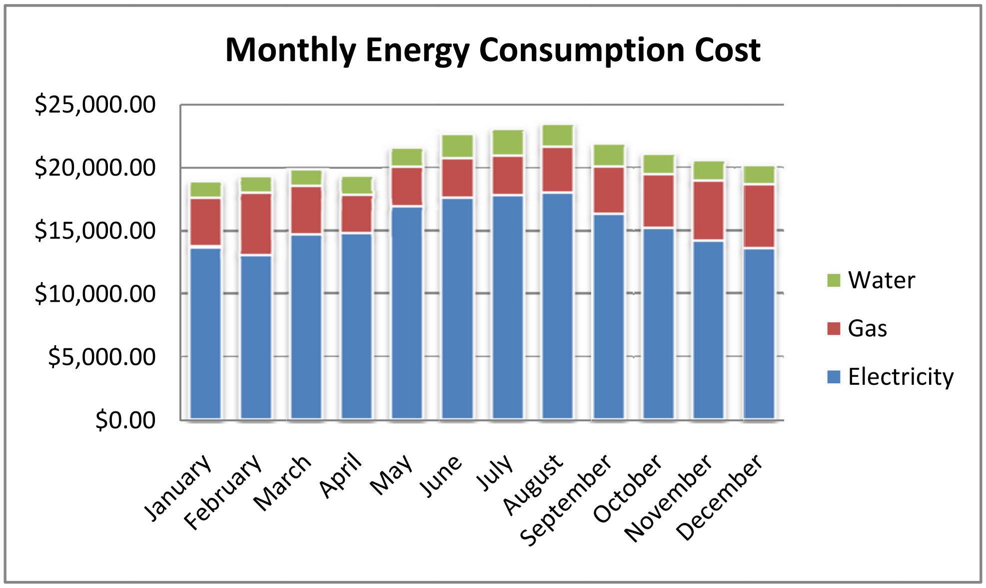


Figure 2-8: Energy Consumption and Cost per Month

The annual energy consumption cost can be used to find the annual operating cost for the various mechanical equipment, lighting, and receptacle loads as seen in Figure 2-9 below. The mechanical costs can be subdivided into space heating, the fluid cooler and cooling tower, and the various fans. Since the space heating requires a gas-fired boiler, the gas charge is added on to the equipment's total cost. Also, the cooling tower utilizes water to reject heat from the water source heat pump loop; therefore the water charge is an addition to the cooling tower's electrical charge.

	Percentage of Electricity Cost		Gas Charge	Water Charge	Total Cost
Lighting	20.0%	$185,933.57	$0.00	$0.00	$37,186.71
Space Heating	2.0%	$185,933.57	$46,784.46	$0.00	$50,503.13
Fluid Cooler	20.0%	$185,933.57	$0.00	$0.00	$37,186.71
Pumps	6.0%	$185,933.57	$0.00	$0.00	$11,156.01
Cooling Tower	1.0%	$185,933.57	$0.00	$19,387.08	$21,246.42
Fans	13.0%	$185,933.57	$0.00	$0.00	$24,171.36
Receptacles	38.0%	$185,933.57	$0.00	$0.00	$70,654.76
Total					$252,105.12

Figure 2-9: Annual Energy Consumption for Mechanical Equipment, Lighting and Receptacle Loads

In order to compare the building's energy performance to other similar buildings, the annual cooling and heating cost per square foot should be determined. From Figure 2-9, the fluid cooler and cooling tower make up 21% of the primary cooling load. That results in an annual cooling cost of $58,433.13 for 62,913 square feet of conditioned space. By taking the quotient of these two values, the annual cooling cost per square foot of conditioned space is $0.93/square foot. Similarly, the annual heating cost is $0.80/square foot.

Overall, the Trace model provided a reasonable building and plant energy analysis. By providing various building information components, and the characteristics of these components, the building load and ventilation summary can be generated. With the use of schedules, mechanical equipment and the corresponding heating and cooling plants, the quantity of conditioning the building needs can also be calculated. Using the individual utility consumptions, an accurate operating cost can be determined. The final operating cost per square foot will provide a unit of measurement that can used to compare the building's energy performance to other similar buildings.

References

McClure Company. 2006. Mechanical Documents. McClure Company, Harrisburg, Pennsylvania. 2008.

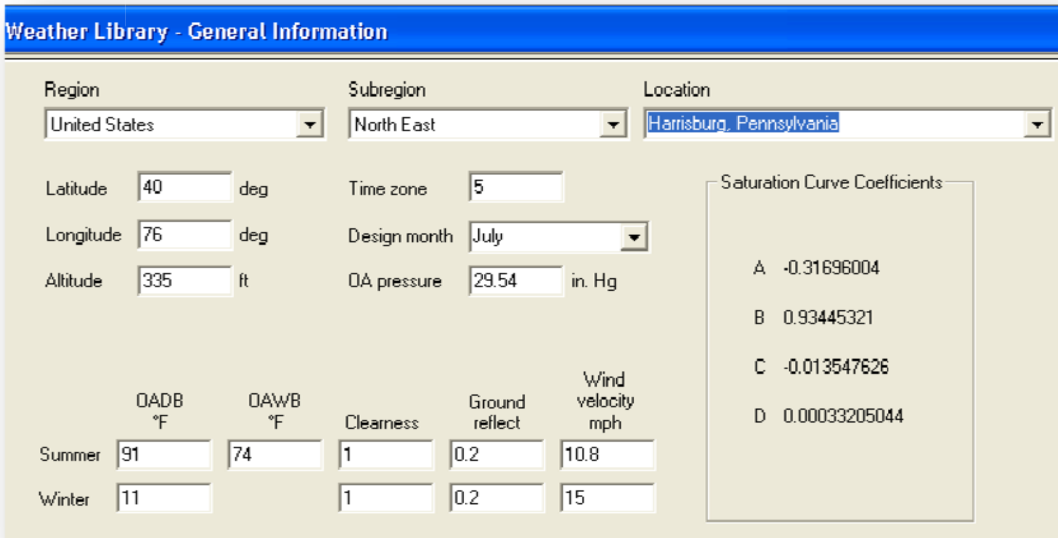
Rate GS-3 2008 Calculation Form. PPL Corporation. 20 Oct. 2008. <http://www.pplweb.com>

Trace 700. Computer Software. C.D.S. Applications, 2008.

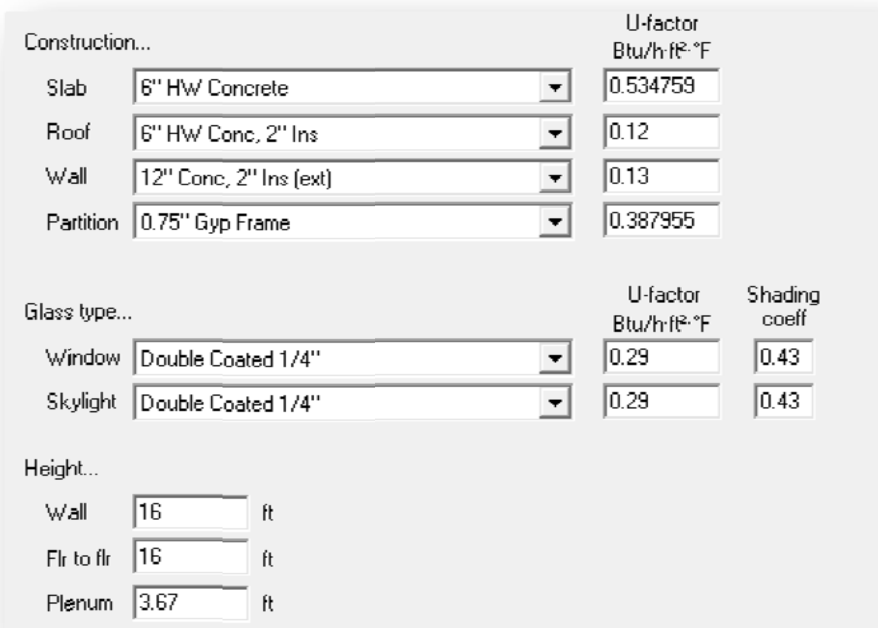
Appendices

Appendix A – Trace Data Inputs
Appendix B – Trace Schedules
Appendix C – GS3 Rate Schedule

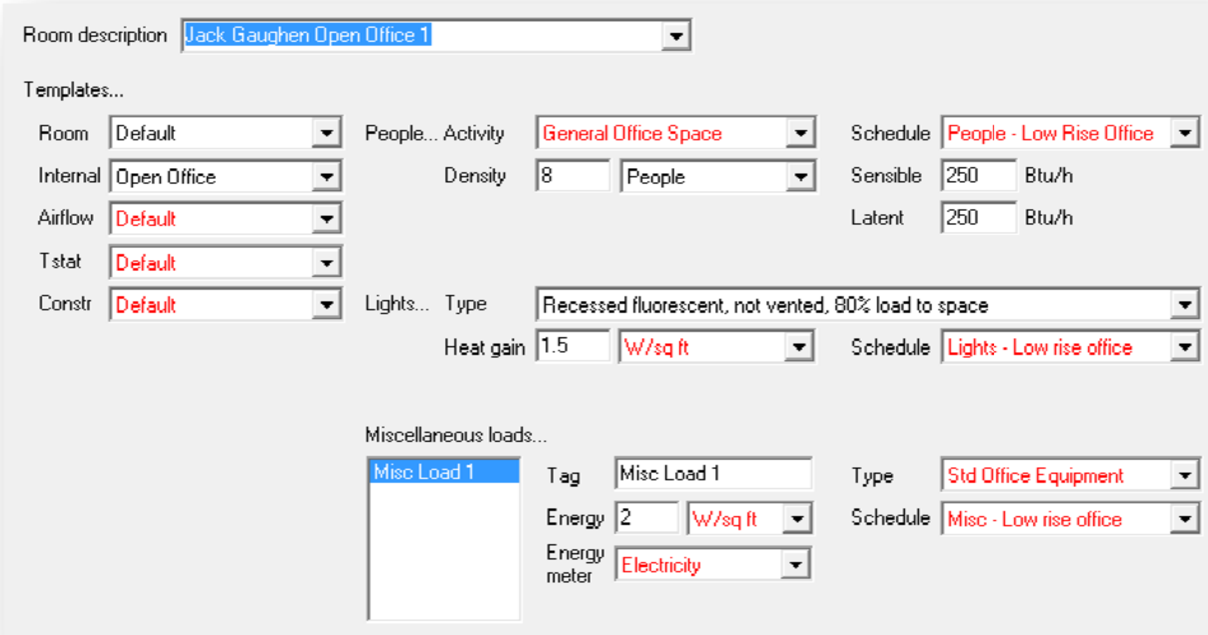
Appendix A – Trace Data Inputs



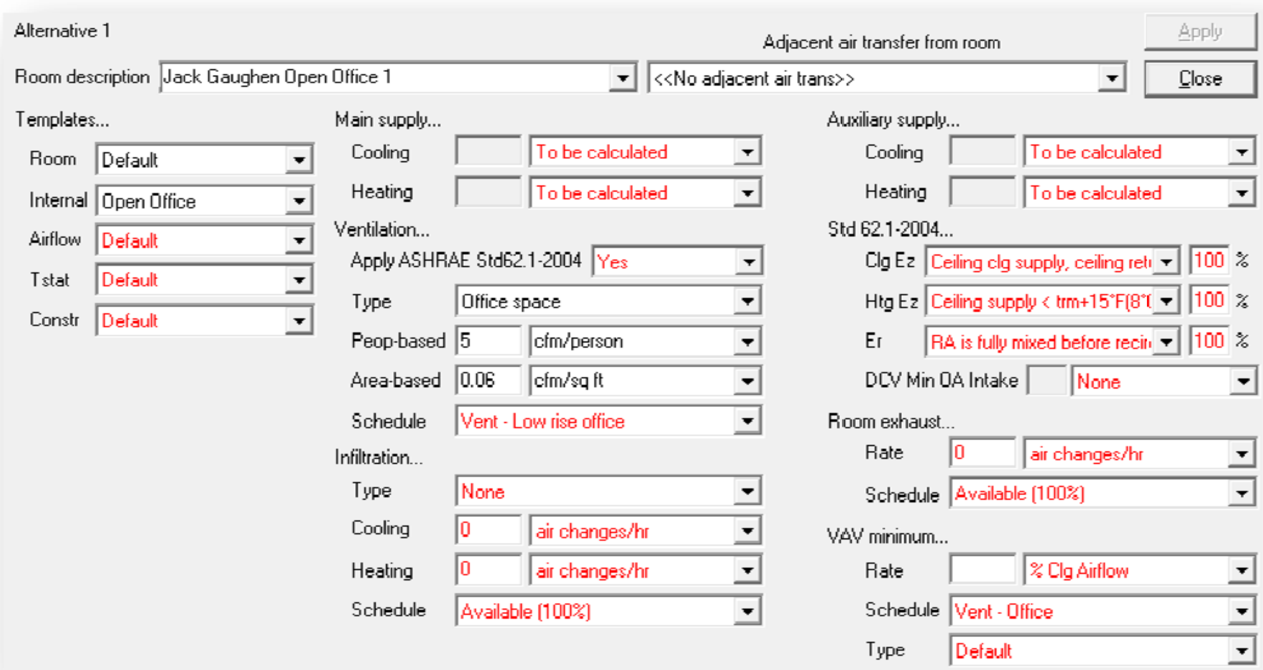
Harrisburg, Pennsylvania Weather Conditions



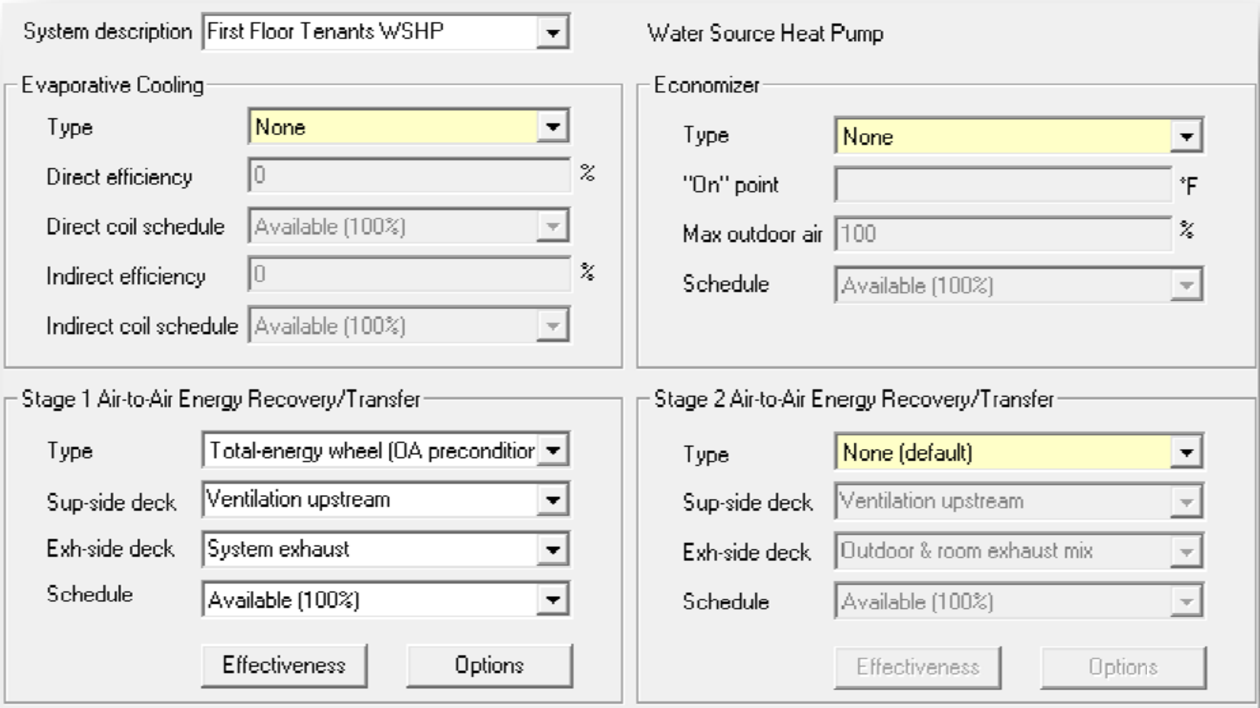
Hershey Press Building Construction



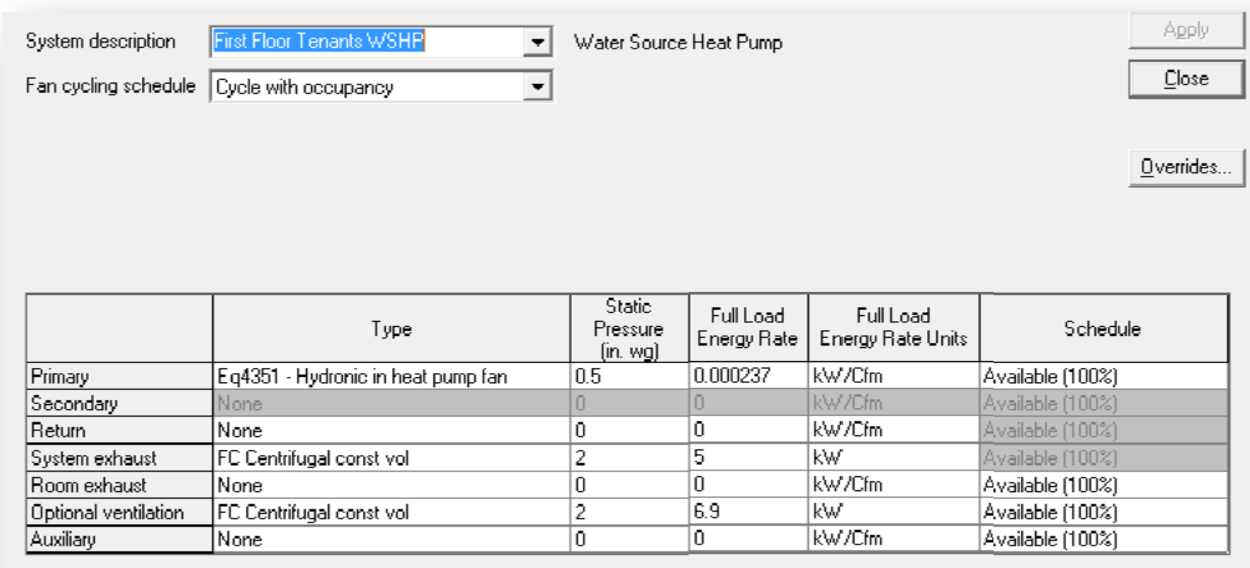
Typical Office Internal Loads Sheet



Typical Office Airflows Sheet

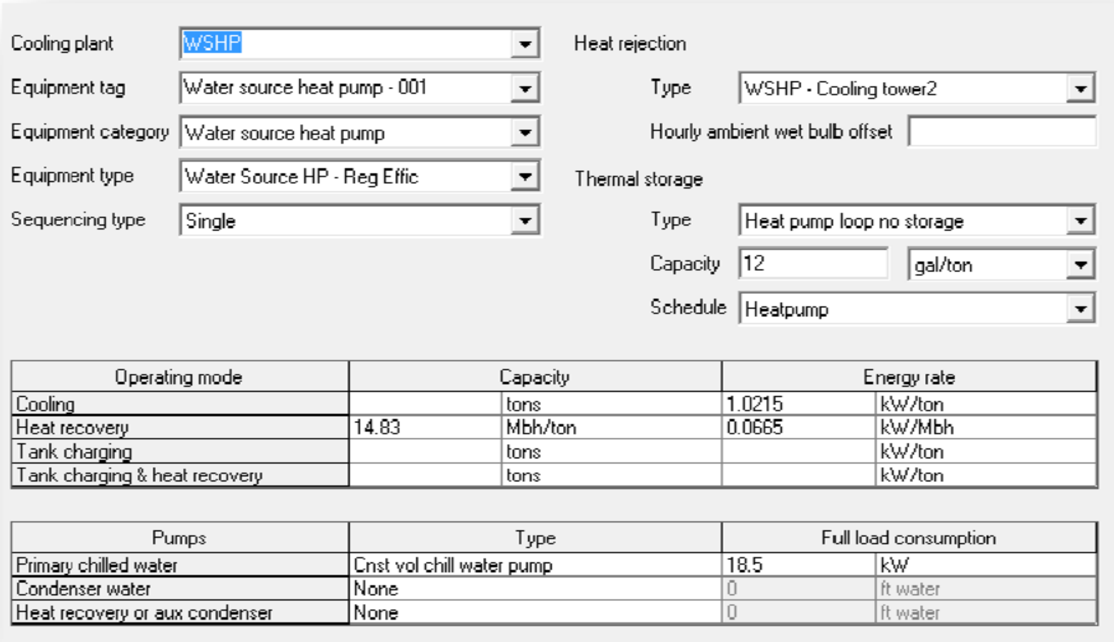


Water Source Heat Pump Options



	Type	Static Pressure (in. wg)	Full Load Energy Rate	Full Load Energy Rate Units	Schedule
Primary	Eq4351 - Hydronic in heat pump fan	0.5	0.000237	kW/Cfm	Available (100%)
Secondary	None	0	0	kW/Cfm	Available (100%)
Return	None	0	0	kW/Cfm	Available (100%)
System exhaust	FC Centrifugal const vol	2	5	kW	Available (100%)
Room exhaust	None	0	0	kW/Cfm	Available (100%)
Optional ventilation	FC Centrifugal const vol	2	6.9	kW	Available (100%)
Auxiliary	None	0	0	kW/Cfm	Available (100%)

Water Source Heat Pump Fans



Cooling plant: WSHP
Equipment tag: Water source heat pump - 001
Equipment category: Water source heat pump
Equipment type: Water Source HP - Reg Effic
Sequencing type: Single

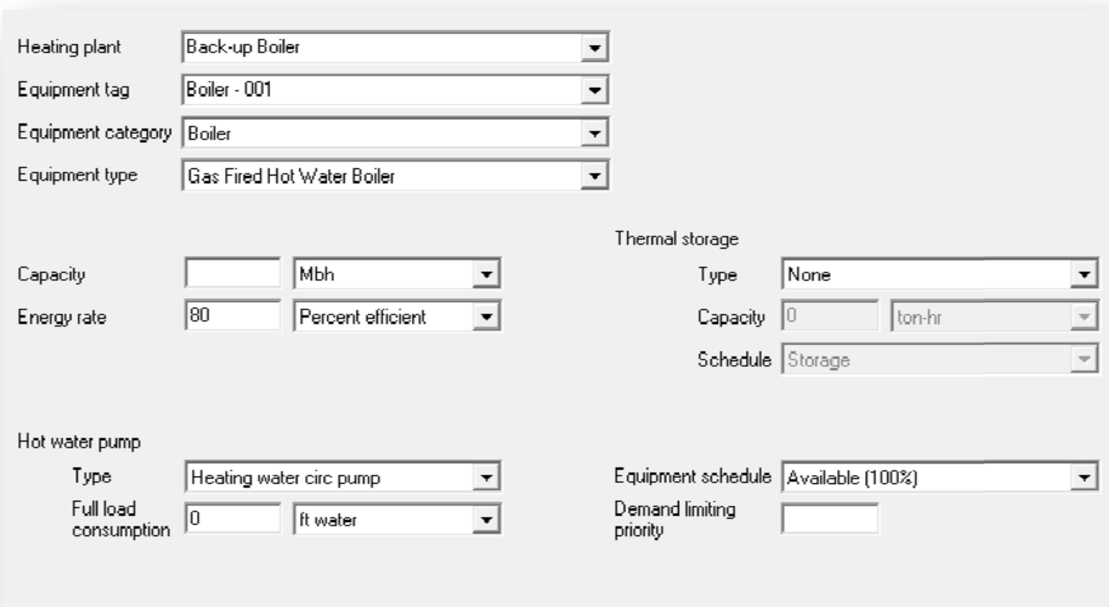
Heat rejection
Type: WSHP - Cooling tower2
Hourly ambient wet bulb offset:

Thermal storage
Type: Heat pump loop no storage
Capacity: 12 gal/ton
Schedule: Heatpump

Operating mode	Capacity		Energy rate	
Cooling		tons	1.0215	kW/ton
Heat recovery	14.83	Mbh/ton	0.0665	kW/Mbh
Tank charging		tons		kW/ton
Tank charging & heat recovery		tons		kW/ton

Pumps	Type	Full load consumption	
Primary chilled water	Cnst vol chill water pump	18.5	kW
Condenser water	None	0	ft water
Heat recovery or aux condenser	None	0	ft water

Cooling Plant Summary



Heating plant: Back-up Boiler
Equipment tag: Boiler - 001
Equipment category: Boiler
Equipment type: Gas Fired Hot Water Boiler

Capacity: Mbh
Energy rate: 80 Percent efficient

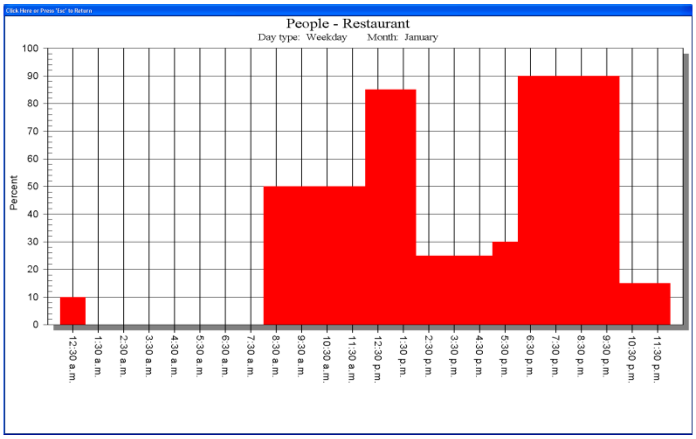
Thermal storage
Type: None
Capacity: 0 ton-hr
Schedule: Storage

Hot water pump
Type: Heating water circ pump
Full load consumption: 0 ft water

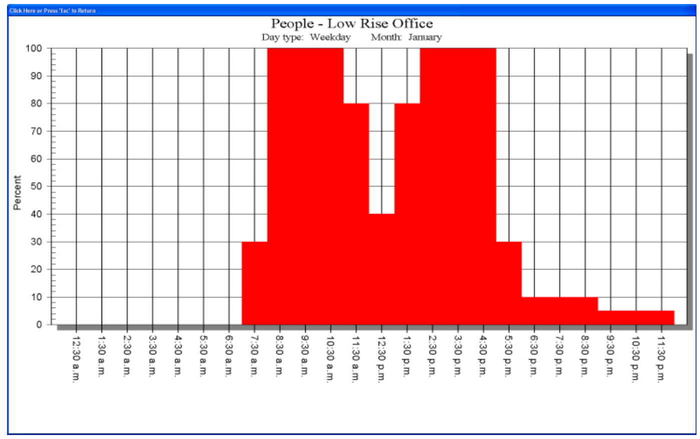
Equipment schedule: Available (100%)
Demand limiting priority:

Heating Plant Summary

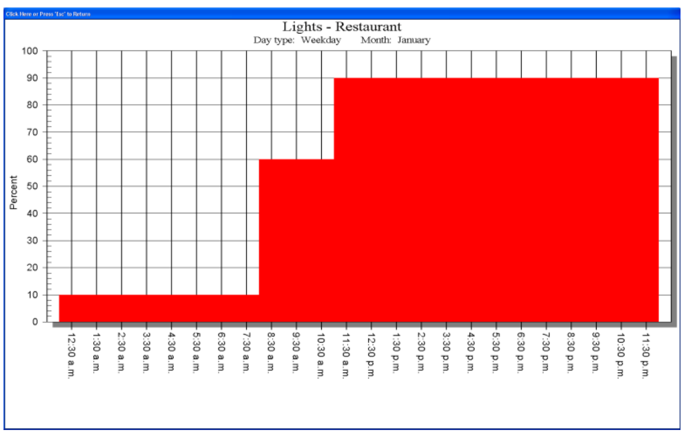
Appendix B – Trace Schedules



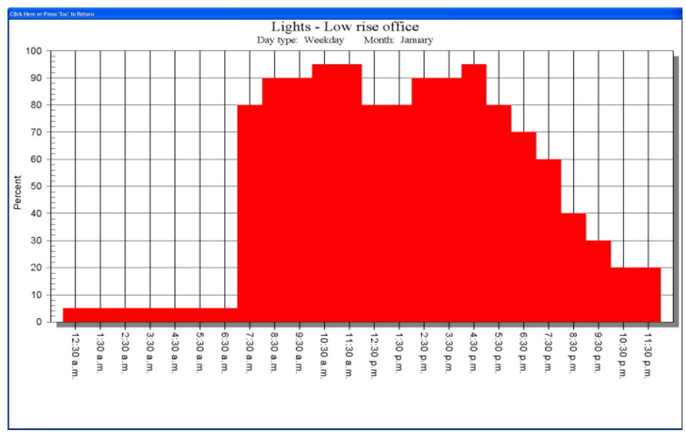
Schedule of Time vs. People for Restaurants



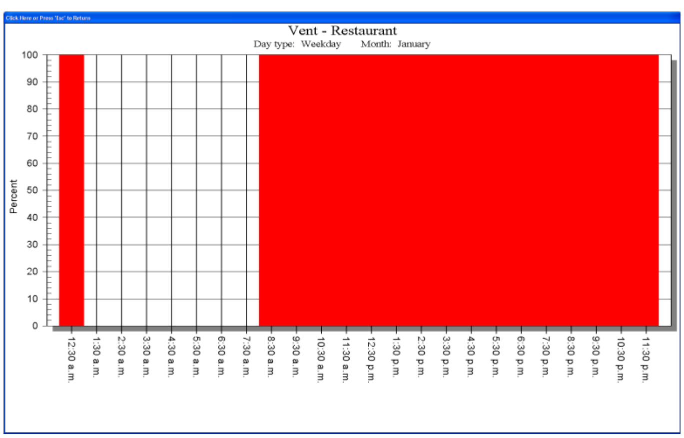
Schedule for Time vs. People for Low Rise Offices



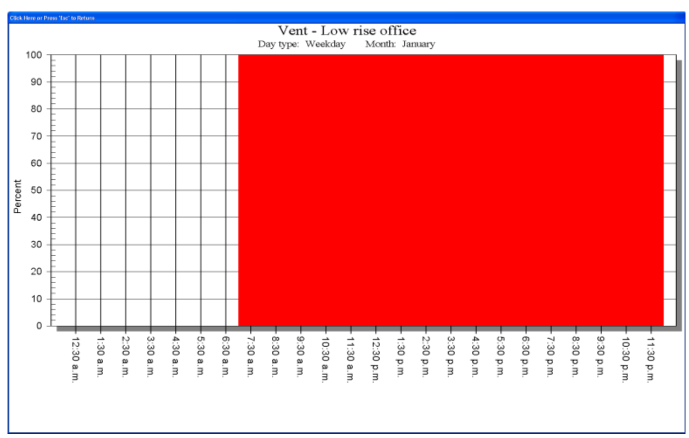
Schedule of Time vs. Lights for Restaurants



Schedule for Time vs. Lights for Low Rise Offices



Schedule of Time vs. Vent for Restaurants



Schedule for Time vs. Vent for Low Rise Offices

Appendix C – GS3 Rate Schedule

Date:				GS3 Rate, Prices 2008				
	Customer : Hershey Press Building							
	Billing Period Ending :		January					
	Actual Demand :			415 KW		EDI/IDI	0 KW	
	Kilowatt Hours :			153,208 KWH		Base:	0 KWH	
	Billing Demand:			415 KW		EDI/IDI?: N		
	Hours of Use:			n/a			Shopping Customer	
				DISTRIBUTION				
$4.380	/KW for all KW of demand:					415 kW	$1,817.70	(A)
(1)	($0.00040) for the first 200 KWH for each Kw of demand							
	200	x	415	=		83,000		
	Cost=	($0.00040)	x	83,000		KWH =	($33.20)	(B)
			Remaining KWH =	70,208				
(2)	($0.00040) for the next 200 KWH for each Kw of demand							
	200	x	415	=		83,000		
		($0.00040)	x	70,208		KWH =	($28.08)	(C)
			Remaining KWH =	0				
(3)	($0.00040) for all additional							
		($0.00040)	x	0		KWH =	$0.00	(D)
					Total KWH Cost (B+C+D) =		($61.28)	(E)
					Distribution Total (A+E) =		$1,756.42	(F)
				TRANSMISSION				
$0.000	per kW for all kW of demand:				0.000 x	415	$0.00	(G)
	$0.00507	for all kWh						
(1)								
	$0.00507	/kWh		0.00507	x	153,208 =	$776.76	(H)
					Transmission Total (G+H) =		$776.76	(I)
				ENERGY & CAPACITY				
	Capacity supplied by PPL Electric Utilities:			100% x	415	= 415.0	kW	
	Energy supplied by PPL Electric Utilities:			100% x	153,208	= 153,208	kWh	
$4.461	/kW for all capacity purchased from PPL:				4.461 x	415 =	$1,851.32	(J)
(1)	$0.04940	for the first 200 kWh for each kW of capacity						
	200	x	415	=		83,000		
	Cost=	$0.04940	x	83,000		KWH =	$4,100.20	(K)
			Remaining KWH =	70,208				
(2)	$0.03760	for the next 200 kWh for each kW of capacity						
	200	x	415	=		70,208		
		$0.03760	x	70,208		KWH =	$2,639.82	(L)
			Remaining KWH =	0				
(3)	$0.03593	for all additional						
		$0.03593	x	0		KWH =	$0.00	(M)
					Total KWH Cost (K+L+M) =		$6,740.02	(N)
					Energy & Capacity Total (J+N) =		$8,591.34	(O)
				COMPETITIVE TRANSITION CHARGE				
$0.000	/KW for all KW of demand:						$0.00	(P)
(1)	$0.00207	for the first 200 KWH for each Kw of demand						
	200	x	415	=		83,000		
	Cost=	$0.00207	x	83,000		KWH =	$171.81	(Q)
			Remaining KWH =	70,208				
(2)	$0.00162	for the next 200 KWH for each Kw of demand						
	200	x	415	=		70,208		
		$0.00162	x	70,208		KWH =	$113.74	(R)
			Remaining KWH =	0				
(3)	$0.00156	for all additional						
		$0.00156	x	0		KWH =	$0.00	(S)
					Total KWH Cost (Q+R+S) =		$285.55	(T)
					Competitive Transition Charge Total (P+T)		$285.55	(U)
				INTANGIBLE TRANSITION CHARGE				
$0.000	/KW for all KW of demand:						$0.00	(V)
(1)	$0.01089	for the first 200 KWH for each Kw of demand						
	200	x	415	=		83,000		
	Cost=	$0.01089	x	83,000		KWH =	$903.87	(W)
			Remaining KWH =	70,208				
(2)	$0.00852	for the next 200 KWH for each Kw of demand						
	200	x	415	=		70,208		
		$0.00852	x	70,208		KWH =	$598.17	(X)
			Remaining KWH =	0				
(3)	$0.00818	for all additional						
		$0.00818	x	0		KWH =	$0.00	(Y)
					Total KWH Cost (W+X+Y) =		$1,502.04	(Z)
					Intangible Transition Charge Total (V+Z)		$1,502.04	(AA)
Time of Day Meter Charge					T.O.D.?: N	(Y/N)	$0.00	(BB)
EDI/IDI Credits								
					Total EDI/IDI Credits =		$0.00	(CC)
State Tax Adjustment Surcharge(STAS): Distribution (F+Z)				x		0.336%	$5.90	(DD)
State Tax Adjustment Surcharge(STAS): (G+M+S+Y+AA)				x		0.310%	$34.58	(EE)
					Pre-tax Total (F+I+O+U+AA+BB+CC+DD+EE) =		$12,952.59	(FF)
					Average Cost per KWH =		$0.0845	
PA Sales Tax					0.00% Exempt			
					(FF x [6% x (100% - Exemption %)]) =		$777.16	(GG)
					Total Bill (FF + GG) =		$13,729.75	
	Average Price to Compare* =		$0.0896	per kWh	Average Cost per KWH =		$0.0896	