Technical Assignment III

Existing Mechanical System Conditions Evaluation

The Hershey Press Building
Hershey, PA

Alyssa Adams | Mechanical Option | November 21, 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. By understanding of the current mechanical system for the Hershey Press Building, a critique for the system can be made.

With this critique, references to constant running water loop pumps, additional heat rejection during the summer from the walk-in coolers, possible indoor air quality issues with ventilation air, maintainability of the heat pumps, and kitchen fan/exhaust equipment conditioning were areas in which more research could be done to help the building. The heat pump design, which met the preliminary project requirements, was a positive critique of the overall mechanical system.

The mechanical system began with a series of design objectives that included zone control and efficiency. The system also needs to fit into the existing architecture as well as be controlled efficiently; these became the project set of goals. Factors, including site logistics and existing shaft and mechanical space, influenced the design process.

Once the factors and goals were conceived, a mechanical design was developed. Design ventilation requirements and outdoor/indoor design conditions became an important tool to size and choose a system. Once a system was chosen, a heating and cooling load could be estimated for each building space. Schematics and schedules, additional support to the floor plans, help summarize the system once designed. These values, tables, and figures can be found within the text.

Controls for each piece of equipment also needed to be developed. An efficient sequence of operation was designed for each piece of equipment for the building to ensure proper system control and reliability.

An energy model was created once the design for all four tenant designs was completed. This model estimated the amount of gas, water, and electricity the building consumed annually. Using the current rates of utilities, an annual cost was also estimated. This information was compared to the actual building's utility bills. With the two values side-by-side, the actual model and the design model were relatively close, even with the exclusion of Devon Seafood in the actual model. LEED, Leadership in Energy and Environmental Design, was used to "improve the quality of building and their impact on the environment (LEED 2005). The rating system for LEED shows that the Hershey Press building was more efficient than an ASHRAE 90.1-2007 base building by 17.2%.

From this information, a critique of the current system could be addressed. While the system design was an energy efficient design that fit well within the Press Building's architecture, there are a few design challenges and problems the building is currently facing. By addressing these problems and providing possible solutions, the cost, indoor air quality, and thermal comfort can be improved for the building and its occupants.

The Project

When Sasaki Architects and McClure Company tackled the renovation of the Hershey Press Building, there were many elements of the project that challenged their design capabilities. The first challenge was to meet a series of design objectives, agreed upon by the project team, to ensure a balance between the mechanical design and the architecture. These objectives included system control in multiple zones, integration of the structural, mechanical and architectural systems, as well as energy efficiency and life cycle cost. Another consideration was site logistics; The Hershey Press Building, located in the center of town and being renovated to the original 1915 look, required many sound, aesthetic, and monumental qualities it had to live up to. Finally, the interior layout of building also affected the mechanical upgrade the building was about to see. The reuse and location of vertical shaft space and horizontal mechanical space locations became a main focal point during the mechanical redesign.

As stated above, the Hershey Press Building original design process began with a series of project objectives. By identifying objectives prior to design, it enhanced design decisions could be made in order to meet the final requirements. These objectives included:

- Multiple zone temperature control with the ability heat and cool zones simultaneously
- Energy efficiency and life cycle cost optimization
- Simplicity of control and control reliability
- Integration with existing architecture and structural systems

The design currently incorporates 93 zones of water source heat pump temperature control over the first, second, and third floors, with one heat pump serving the basement. A desiccant heat recovery wheel in the two energy recovery ventilators improves the efficiency of the outside air conditioning.

The HVAC system will utilize a direct digital control/automatic control system that will provide temperature control, scheduling, energy management, alarm, monitoring and trending functions. The computer workstation with graphical interface was provided with modem remote monitoring capabilities.

The majority of the HVAC equipment, with the exception of the fluid cooler, is housed in the basement to minimize the aesthetic impact the mechanical system had with the original façade renovation. Since the construction in 1915, the Hershey Press Building's main focus was to restore the building to its original presence. This prohibited the majority of equipment from being visible, which was one of the major design objectives.

Design objectives were not the only influences during the design development phase. Site factors and other issues played a large role. The site, for example, is surrounded by the building seen in Figure 3-1. Enclosed site logistics, acoustical properties of the site, and centrality of the building as a town monument became factors in the mechanical design.

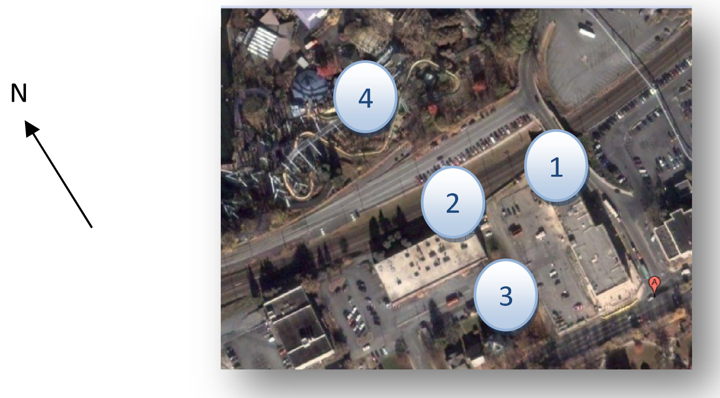

Figure 3-1: The Intersection of Chocolate & Park Avenue in Hershey, PA

The numbers in Figure 3-1 depict the following buildings:

1. Hershey Press Building
2. Parking Garage
3. Hershey Museum (Under Construction)
4. Hershey Park Amusement Resort

The office and restaurant parking, located west side of the building, occupies the majority of the free space surrounding the building. With the enclosed site, many opportunities for setting large mechanical equipment outside on site, an air-cooled chiller example became an impractical choice. Another factor the design would have to balance was the noise factors from the nearby amusement park and the lack of noise generated near the Hershey Museum. Careful consideration needed to be taken when designing the location of mechanical rooms and equipment placement, to neither add noise to the nearby area, nor leave the building open to noise from the nearby rollercoaster.

The south façade, as seen in Figure 3-1, faces Chocolate Avenue, the main artery in the town of Hershey, Pennsylvania. Renovating the façade became a focal point in the downtown revitalization movement. Becoming a monument of change and beauty within the community challenged to project team, especially the mechanical designer, to ensure that the aesthetics of building would not be compromised. In all, the site affected exterior and acoustic decisions made to the building by the entire project team.

The exterior was not the only issue; the interior layout also impacted many design decisions during renovation. Also, additional shaft space was integrated into the architectural scheme to accommodate all three floors, without disturbing the structural concrete integrity. Below, in Table 3-1, is a breakdown by floor of the lost usable space associated with the mechanical system design, including both the mechanical equipment floor space area and the vertical mechanical shaft area.

With the current floor plan, the entire mechanical system floor space is located in the basement. This is broken down into 431 square feet of boiler room space and 2,281 of shared mechanical and storage space.

Table 3-1: Breakdown of Lost Useable Space Associated with the Mechanical System

	Mechanical System Floor Space (Sq. Ft)	Vertical Mechanical Shaft Area (Sq. Ft.)
Basement	2712	30
First Floor	0	32
Second Floor	0	32
Third Floor	0	32

The location of mechanical rooms and vertical shaft locations can be seen for the basement in Figure 3-2. The shaft locations from the first through third floors can be seen in Figure 3-3. While the boiler room is purely mechanical equipment, the "Mechanical Room/Houlihan's Storage" is a shared space of Houlihan's miscellaneous restaurant items and mechanical equipment. Notice there are four shafts from the basement to the first floor depicted in Figure 3-2 utilized for exhaust fans and ERV supply duct. There are also two shafts from the roof the first floor depicted in Figure 3-3 utilized for ERV supply duct.

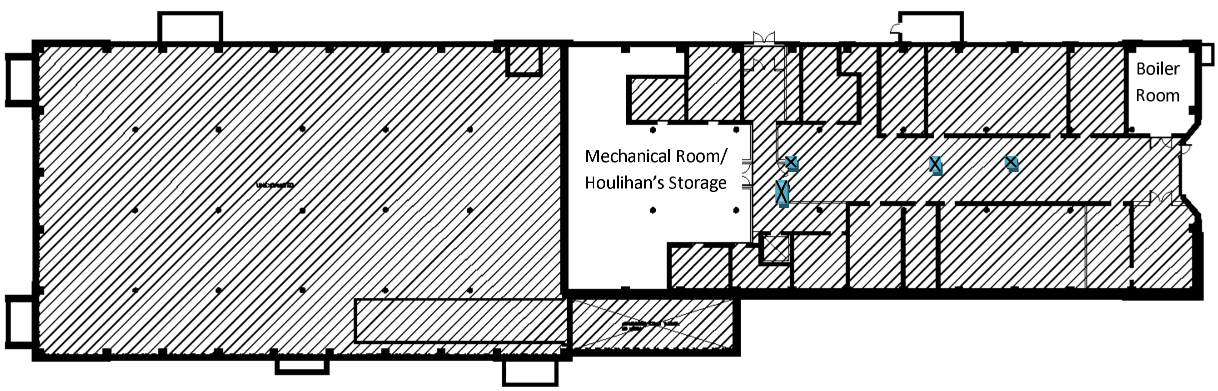

Figure 3-2: Location of Shafts and Mechanical Rooms Located in the Basement

Figure 3-3: Location of Shafts Located on the First, Second, and Third Floors

The System Design

The next step in the Hershey Press Building renovation design process was to choose a mechanical system. By choosing and calculating the design conditions and ventilation requirements, an accurate system model can be made, in this case, using Trane Trace software. The software will provide the necessary heating and cooling loads for the entire building. Using this information, equipment can be chosen and laid out for the building, including simplified system schematics. A schematic is a simplified version of a mechanical floor plan, showing the relationship between equipment, air flows, and other values with a flexible level of detail. Controls are also designed for system operation and detailed in a sequence of operating. Finally, after the design is completed, a cost analysis of the entire mechanical system can be estimated for bid and budgeting purposes.

The first step in the design, while considering equipment, is to find the minimum outside air required for the project. Because the Hershey Press Building's mechanical system was designed in four different tenant-fit out designs, two standards were followed: the International Mechanical Code 2003, Section 403.3 and ASHRAE Standard 62.1-2004. During the first mechanical design, the designer chose two energy recovery ventilators that were used as dedicated outside air sources. Each ERV utilized an enthalpy wheel placed between the exhaust and ventilation air flows. The first energy recovery ventilator, ERV-401, was designed to handle the outside air requirements of the basement, the second and the third floors. The second, ERV-402, was designed for future first floor use. After the fourth and final tenant fit-out design was completed, the final ventilation air flow was chosen for the entire first floor. Values for both ERVs can be found in Table 3-2, under the "Design Min. O/A" column.

Table 3-2 also shows the comparison between the calculated and designed ventilation air requirements. In Technical Assignment I, the required minimum outside air, V_{ot}, was calculated for ERV-402. The calculated and as-designed ventilation values were compared. ERV-402 met and exceeded ASHRAE Standard 62.1-2007. The original design values were 65% or more than the minimum Standard 62.1-207 required. One reason for the over estimate was to ensure that the required ventilation air was being supplied to each space from the ceiling plenum without having to direct duct the air to the individual heat pumps.

Table 3-2: Design Ventilation Requirements for the Hershey Press Building

Hershey Press Building Energy Recovery Ventilator (ERV) Design Ventilation Requirements			
Calculated Minimum Ventilation		As-Designed Minimum Ventilation	
ERV	Calculated V_{ot} (CFM)	Design Min. O/A (CFM)	Meets Std. 62.1-2007?
ERV-401	-	8,720	-
ERV-402	7,011	9,600	YES
Total	7,011	18,320	YES

Next, the outdoor and indoor design conditions needed to be decided. McClure company engineers decided upon the following general design conditions:

- Summer outdoor condition: 92°F DB/74°F WB
- Winter outdoor condition: 0°F DB
- Summer indoor condition: 72°F DB, not to exceed 60% relative humidity
- Winter indoor condition: 70°F DB

This information, along with individual thermal room criterion, was entered in a load simulation program. This process was repeated for all four tenant fit-outs. The program was then able to estimate the design heating and cooling loads of the space. See Table 3-3 below for the calculated values for the entire building, modeled during Technical Assignment II and the as-designed values, modeled during the original design. Supply air, vent air, cooling loads and heating loads, in terms of area, for both the calculated and as-design, are compared in Table 3-4.

Table 3-3: Calculated and As-Designed Heating and Cooling Mechanical Loads

<table>
<tr><th colspan="5">Hershey Press Building
Heating and Cooling Loads</th></tr>
<tr><th rowspan="2">Occupancy & Floor</th><th colspan="2">Calculated Thermal Loads</th><th colspan="2">As-Designed Thermal Loads</th></tr>
<tr><th>Calculated Heating Load (MBH)</th><th>Calculated Cooling Load (Tons)</th><th>As-Designed Heating Load (MBH)</th><th>As-Designed Cooling Load (Tons)</th></tr>
<tr><td>HE&R (partial basement and 2nd & 3rd Floor offices)</td><td>471</td><td>122</td><td>1,845</td><td>136</td></tr>
<tr><td>Houlihan's restaurant (1st)</td><td rowspan="3">778</td><td rowspan="3">86</td><td>637</td><td>44</td></tr>
<tr><td>Jack Gaughen Realty offices (1st)</td><td>454</td><td>19</td></tr>
<tr><td>Devon Seafood restaurant (1st)</td><td>26</td><td>39</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>1,249</td><td>208</td><td>2,962</td><td>238</td></tr>
</table>

One noticeable difference from Table 3-3 shows the heating and cooling loads are greater for the as-designed. During the original design, the calculations for a heat pump were based on the cooling and heating load without ventilation. A summary of this calculation can be seen in Figure 3-4. Ventilation was added to the load afterwards and a heat pump was selected, based on the higher of the two heating and cooling values. Eventually, the heat pump size was based on the cooling, and the heat pump cooling and heating capacities became the designed heating and cooling loads.

As-Designed 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 3-4: As-Designed Heat Pump Sizing Calculations

Each heat pumps heating value is proportional to the cooling value. Therefore, the cooling need is greater than the heating need in all the heat pumps; the heating capacity is oversized based on need. While the entire heating capacity will rarely be utilized, it is still represented as a possibility for the as-designed conditions. This would explain the inflated as-designed value. This trait is also represented in Table 3-4, showing the area per MBH required for the building.

The cooling value for the as-designed is also much higher than what was calculated. This is because the engineer rounded up to the nearest heat pump's cooling capacity and summed the final heat pump tonnage as the total cooling load. It is necessary to point out that the heat pumps will rarely see full capacity output; typically, the heat pumps will condition the air at part load to meet the spatial requirements.

Building Airflow Values in Terms of Area				
	Cooling Load ft^2/ton cooling	Heating Load ft^2/MBH heating	Supply Air cfm/ft^2 supply	Vent Air cfm/ft^2 vent
Calculated	303.0	50.5	1.93	0.30
As-Designed	264.8	21.3	2.09	0.32

Table 3-4: Calculated and As-Designed Airflow Values in Terms of Area

Once the required loads are calculated, equipment can be selected. Water-source heat pumps became a logical choice for the designers, because it allowed the Hershey Press Building to take advantage of the large ceiling space, while minimizing the necessary shaft and mechanical space. Appendix A – Equipment Schedules has a list of the major equipment specified and the performance of each piece of equipment. All temperatures are in degrees Fahrenheit. Also, the heat pumps were sized based on cooling capacity (80°F DB/67°F WB EAT and 90°F EWT) and the heating capacity (70°F DB EAT and 60°F EWT).

With the equipment selected, floor plans can be created. Schematics can also be used to simplify the floor plans for a better logical understanding of the system. The first schematic, located in Figure 3-5, shows the water loop heat pump. The boilers are shown in parallel. The reason for this will become more apparent in the control sequence section of the report.

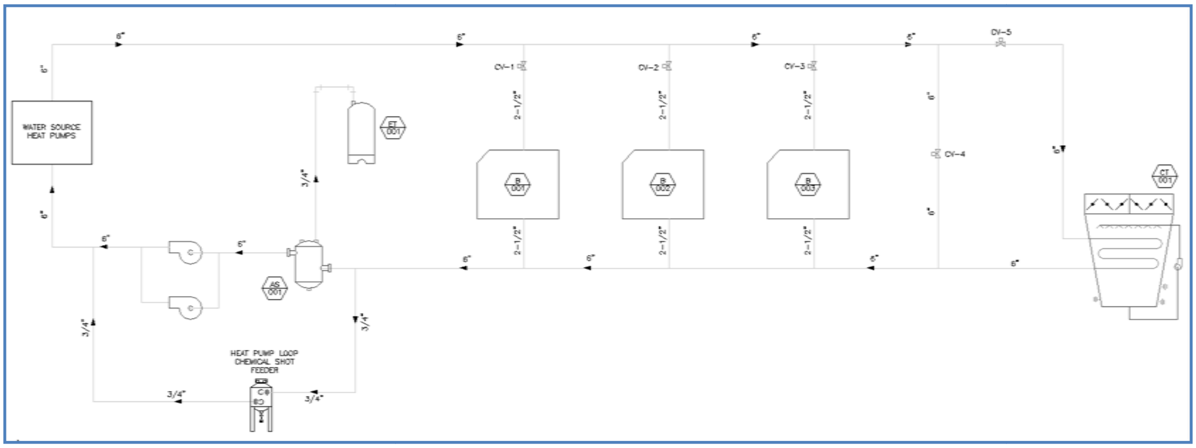

Figure 3-5: Water Source Heat Pump Loop Schematic

The schematic shows five control valves that will divert the flow depending on the temperature of the loop. An expansion tank (ET-001) and an air separator (AS-001) are used to maintain the correct loop water pressure. A heat pump loop chemical shot feeder is used to disinfect any micro bacterial growth. Two pumps, one lead and one lag, are being used the pump the loop to the water sources heat pumps, located on all three floors and basement.

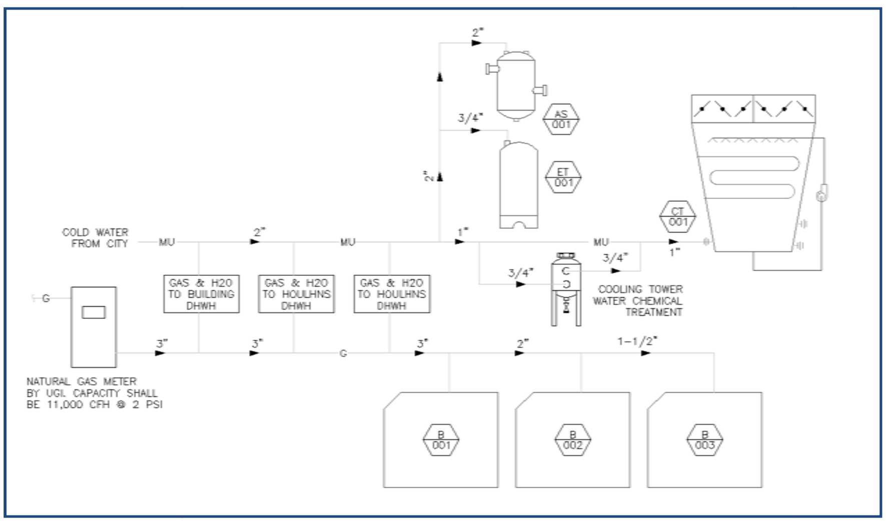

Figure 3-6: Gas and Make-Up Water Schematic

In Figure 3-6, the gas and make-up water schematic is shown. This shows the relationship between the city access point and the distribution to the mechanical equipment. All three domestic water heaters utilize the water and gas utilities. The cooling tower water chemical treatment connection allows additional chemical to be added to the water to purify the fluid cooler, once utilized in the system. A connection to the air separator and expansion tank assists the equipment in regulating pressure. This schematic, and the water loop heat pump schematic, are both helpful in visualizing the system components and relationships.

After the design is relatively closed to being completed, a project cost can be estimated for the mechanical system. The total project cost includes labor and materials, as well as overhead and profit for the contractor. See Table 3-5 for a breakdown of the system total cost and cost/area. The cost per area value is often calculated to show a more comparable, relative value. Notice that both restaurants, Houlihan's and Devon, have a higher mechanical cost. This is due to the large kitchens loads and equipment. It is also important to notice that both the offices, and the restaurants, vary 1% in cost/area from each other. This shows that the estimate is reasonable in terms of cost per square foot for the different occupancy types.

Table 3-5: Mechanical System Total First Cost and First Cost per Area

	Mechanical System Total First Cost	Mechanical System First Cost/Area
HE&R	$914,000	$21.57/sq. ft
Houlihan's	$365,000	$53.36/sq. ft
Jack Gaughen	$110,000	$21.32/sq. ft
Devon Seafood	$462,000	$54.14/sq. ft
Total	**$1,851,000**	**$29.42/sq. ft**

Overall, the design process to choose an efficient system that met the list of criterion was quite successful. While starting with the necessary design conditions and ventilation requirements, an accurate system model can be created with Trane Trace software. The software was able to provide the necessary design heating and cooling loads, for each zone of the building. With an overall system in mind, equipment was chosen and floor plans for the system were created. These plans included simplified system schematics, for both the water source heat pump loop and the gas/water systems, servicing the mechanical equipment. Once the design was at an adequate completion stage, controls sequences could be developed to control the major pieces of equipment. Once the design was completed, the final cost analysis of the entire mechanical system was found.

The Control System

Once the system is designed, a control sequence can be determined. This sequence will ensure proper operation of all equipment and the integration of system components. The master controller for the system is an American Auto-Matrix Sage Panel. Coupled with a personal computer, Sage has graphic interface software in order for building operator's to adjust the final control parameters. The controller is connected to a BAS phone line for dial-up service support from the mechanical contractor. A schematic of the DDC control network summary can be seen in Figure 3-7. Room 221, listed as a room temp sensor, symbolizing one of 94 heat pump sensors linked, in a "daisy chain" fashion, together. A global outside air sensor, located on a north facing wall underneath a sun shield, will be used by the controller to monitor outside air temperatures.

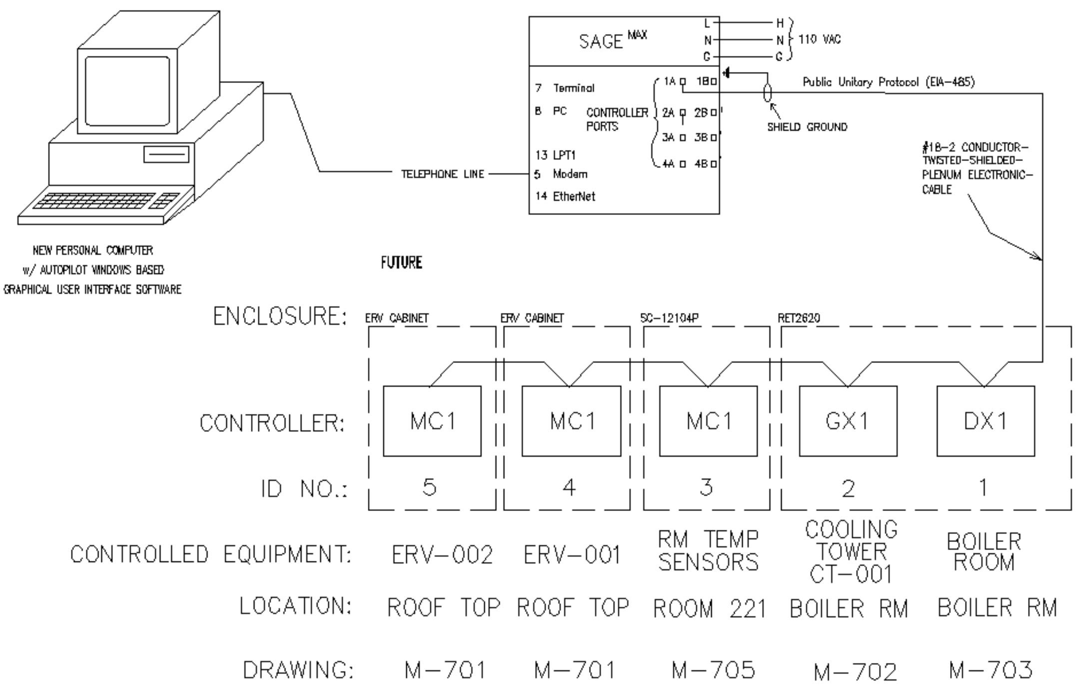

Figure 3-7: Hershey Press Building DDC Control Network Summary

Each piece of equipment has its own sequence of control operation. Details for each control system are shown in the sections below. Appendix B – Valve & Damper Schedule shows valve information (application, size, connection type, normal position, flow rate, pressure drop, and close-off rating) for the valves used on the fluid cooler and boilers and damper information (size, application, operation, and damper make/model) for the boiler and electrical room.

Section 1 –Pumps for the Water Source Heat Pump Loop (HPWP-1 & HPWP-2)

The pump operates in a lead/lag fashion. There are two pumps for redundancy purposes. On a weekly basis, the lead and auxiliary pump alternate in order for equal usage and depreciation to occur. While one pump is acting as lead, it shall run continuously, and at 100% output, for the seven day rotation.

There are no variable drives connected to either pump. In event of a lead pump failure, the auxiliary pump will take over and an alarm will sound.

Section 2 – Boilers (B-001, B-002, & B-003)

Each boiler will rotate on a lead/lag weekly rotation such the each boiler will lead every third week, much like the heat pump water pumps. All the boiler temperature set points are adjustable through the Sage controller. Each boiler will have an alarm output, indicated to the Sage controller, and can alert facility managers as well as the mechanical service contractor in case a boiler needs to be removed from the control sequence for any reason. In this case, the other boilers will operate as normal.

Once the heat pump loop water temperature, detected by the temperature indicator/thermometer and sent to the sage controller by the temperature indicator, falls to 64°F, the fluid cooler isolation valve (CV-5) closes. At this point, the system bypass valve (CV-4) and all three boiler isolation valves (CV-1-3) open. Table 3-6 shows the control sequences for the fluid cooler, by-pass valve, and boilers.

Table 3-6: Hershey Press Building Boiler Control Sequence of Operation

BOILER OPERATION CONTROL SEQUENCE					
	Fluid cooler	By-Pass Valve	Lead Boiler	1st Lag Boiler	2nd Lag Boiler
60°F	OFF	OPEN	ON	ON	ON
62°F	OFF	OPEN	ON	ON	OFF
64°F	OFF	OPEN	ON	OFF	OFF
66°F	OFF	OPEN	OFF	OFF	OFF

Each valve provides real-time feed of their open/close status. The bypass vale and the fluid cooler valve will never be closed at the same time, according to the sequence. Once the boiler approves the proper flow, 40 gpm, the lead boiler will enable and fire to maintain a discharge temperature above 65°F.

If the water loop temperature continues to drop to this point, to a temperature of 62°F, the first lag boiler shall be enabled and fire to maintain the discharge temperature by internal control modulation. In the scenario, if the first two boilers are unable to meet the proper discharge temperature and the water loop drops to 60°F, the second lag boiler will enable and fire.

Once the temperature begins to rise in the water pump loop, the second lag boiler will disable at 62°F and the first lag boiler will disable at 64°F. The lead boiler will disable at a loop temperature of 66°F, the ambient temperature for the loop, and the loop will bypass the boiler completely.

Section 3 – Closed-Loop Fluid Cooler (CT-1)

Continuing with the example above, once the 66°F water loop rises to 85°F, the fluid cooler isolation valve (CV-5) will open and all three boiler isolation valves (CV-1-3) and system by-pass valve (CV-4) will close. At this stage, the heat pumps are rejecting heat to the heat pump loop and further heat rejection of the loop is required.

As the temperature of the loop increases to 86°F, the damper to the fluid cooler will open. At 87°F, the spray pump is energized. With proof the damper is open and at 88°F temperature, the first fan motor will turn on. As the temperature rises an additional degree, to 89°F, a second fan motor is energized. As the temperature decreases, each temperature increment that powered a certain fluid cooler component will deactivate in the same corresponding manor. See Table 3-7 for a summary of the fluid cooler operation. Remember, the temperature set points can be customized.

Table 3-7: Hershey Press Building Boiler Control Sequence of Operation

FLUID COOLER OPERATION CONTROL SEQUENCE						
	Fluid Cooler (FC)	By-Pass Value	FC Damper	FC Spray Pump	FC Fan Motor 1	FC Fan Motor 2
85°F	ON	CLOSED	OPEN	OFF	OFF	OFF
86°F	ON	CLOSED	OPEN	ON	OFF	OFF
87°F	ON	CLOSED	OPEN	ON	ON	OFF
88°F	ON	CLOSED	OPEN	ON	ON	ON

The fluid cooler has a sump pump heater that will energize once the water temperature falls below 40°F. If the cooler would spring a leak or the water level drops below a certain level, a low water cutout switch will de-energize the heater and sound an alarm.

Section 4 – Energy Recovery Ventilator (ERV-401, 402)

Both energy recovery ventilators, located on the roof, operate on an occupancy-based schedule. ERV-401, serving the basement, second floor and third floor, runs from 6:00am to 6:00pm. ERV-401, serving the first floor restaurants and office tenant, operates from 6am to 3am. This occupancy can be adjusted.

When the ERV is in use, also known as occupied mode, the heat wheel is disabled when the temperature of outdoor air stream is between 55°F and 70°F. When the ERVs are in unoccupied mode, both the fans and heat wheel are disabled and the dampers are closed. Smoke detection is also installed in the exhaust duct on the unit. This is used to monitor the exhaust air for smoke, in which case would signal and alarm and fire system, while disabling the unit.

Section 5 – Water Source Heat Pump (HP-001 to 334)

Each water source heat pump will be controlled by an individual, 7-day programmable thermostat. The thermostat, provided by the heat pump manufacturer Florida Heat Pumps, will be mounted in plain view for the offices and in the back of house or the manager's office for the restaurant spaces. Thermostats will be located at ADA compliant wall heights. The heat pumps will maintain a heating dry bulb set point of 70°F and a cooling set point of 72°F during the occupancy schedule of the space.

Section 6 – Boiler Room and Electrical Room Dampers (D-1, 2)

Dampers are used to cool the boiler room and the electrical room, located in the basement of the Press Building. A schedule for the dampers is located in Appendix B. Each damper has its own control sequence, as seen below.

For the boiler room, the damper will open and fan (F-002) will energize if any one of the following occur:

- At least one boiler is enabled
- At least one domestic water heater is enabled
- The ambient room temperature rises above 95°F (and will continue to run until the temperature falls below 95°F)

If the temperature of the boiler room falls below 55°F, a unit heater (UH-002) will turn on and heat the room until the ambient temperature is above the set point.

For the electrical room, the damper will open and fan (F-001) will energize if ambient temperature, much like the boiler room, rises above 95°F. It will continue to run until the temperature falls below the set point. For heating, the unit heater will run at any temperature below 55°F.

Section 7 – Electric Wall, Wall Insert, and Unit Heaters (WH, WIH, UH)

For the remainder of the unit heaters not placed in the boiler or electrical room, the control sequence differs. The automatic control system will enable the heaters when the outdoor air temperature, signaled by the global senor, is less than 50°F or with an override, for occupancy reasons.

The Energy Study

With the design and operation of a mechanical system, the Hershey Press Building must continue to maintain the system to ensure efficiency and extended life cycle of each piece of equipment. By analyzing the current system, an energy study with raw data, and dollars, can commence. The first step is to identify the current energy sources and rates for the site. Next, the annual energy use can be calculated for an estimated mechanical system usage and cost. This data can be compared to the operating history of the system for better accuracy. The building can also be compared to a green building, by utilizing the US Green Building Council LEED-NC rating system. Once these actions are carried out, an overall evaluation of the mechanical system can be determined.

Currently, Derry Township has two forms of energy sources that Hershey buildings can utilize, gas and electric. Both of these utilities run underneath the main avenues, including Chocolate Avenue, and can be accessed by the residents. The electric service, provided by PPL Electric Utilities, has different rate schedules based on customer type and need. The Hershey Press building uses the general service rate three (GS3). A break-down of this rate structure can be found on PPL's website.

Gas, a second energy source, is provided by UGI Utilities Incorporated. The current rate is $12.50/MCF.

A third utility provided to the building, although not necessarily an energy source, is water. The Pennsylvania Area Water Commission is the company that monitors and charges for water usage. The current rate is $0.01/gallon.

Trace was not only used to calculate load and ventilation rates; it also calculated annual energy consumption. Using the same ventilation rates, internal generation rates, and envelope values, Trace was able to estimate the energy consumption required to condition the total 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.

As for the results, electricity was the only utility simulated by the Trace program. According to the power 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 3-8. 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. Using the annual consumption from Trace, the consumption values were inserted in to the PPL GS3 template for a realistic monthly cost to be forecasted.

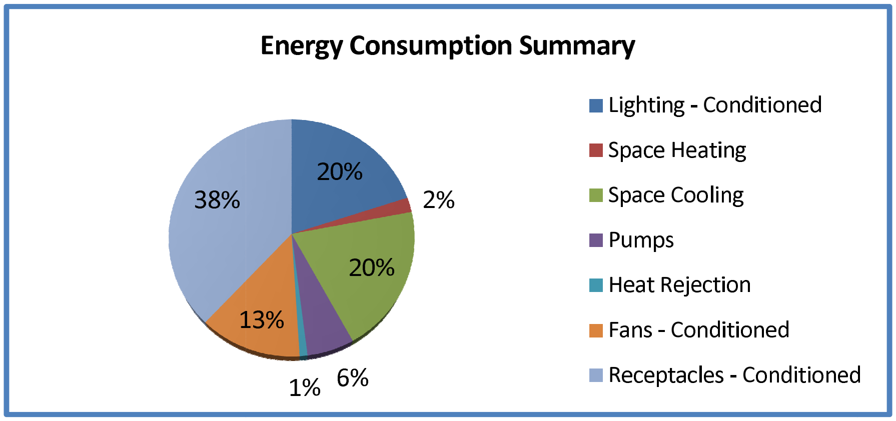

Figure 3-8: Energy Consumption

Natural gas and water usage were calculated by hand. Trace was unable to accurately model the water usage of either the fluid cooler nor the gas consumption for the boiler. For Gas, the boiler was the only piece of mechanical equipment that utilized the natural gas intake. Other gas consumers in the building include the kitchen equipment and domestic water heaters. Using the actual gas utility bills, a base gas consumption value was found in May, which had the lowest gas usage. Boilers were not being utilized during May was a critical assumption made, and the consumption that did occur with this month was constant year round. Taking May's consumption as a base number, and subtracting that value from the remainder of the months, an estimate for the boiler's annual natural gas consumption could be made.

Similarly, the fluid cooler is the only piece of mechanical equipment that utilizes the water utility. With the fluid cooler peaking during the summer months and completely stagnant during January, January became the typical water usage for the entire building. By subtracting this value from the remainder of the months, an approximated water usage by the fluid cooler could be calculated.

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 3-8, 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.

With the calculated electricity, gas, and water consumption and cost values, a comparison to actual utility costs and usages could be determined. Using the Hershey Press Building's actually utility data, electricity for the actual building and the calculated mechanical value could be compared. See Figure 3-13 for the annual utility usage and cost comparison. The detailed worksheet used to find these values for both calculated and actual can be found in Appendix C. Electricity, natural gas, and water were compared back to the original values. It is important to note that the comparison isn't for accuracy, but rather estimated mechanical system utility usage versus total building utility usage.

A pattern for each graph can be found. For the electricity consumption, the graph shows the calculated electricity value almost always being higher than the actual. How can the mechanical power usage be greater than the building's total consumption? Full electrical output of all the Trace variables is one reason, since not all receptacle loads, lights, and full person occupancy typically occurs day to day, the actual power use will be lower. Also, the kitchens will have different peak and off peak times based on customer volume. However, the largest reason for the difference is due to the current electrical utility bills not including the newest tenant fit-out, Devon Seafood restaurant. Modeled in the Trace model, but not added in the actual model, will create quite a deficiency in comparison. Once Devon becomes fully occupied, the new electrical bill can be used to simulate the actual energy consumption of all four fit-outs.

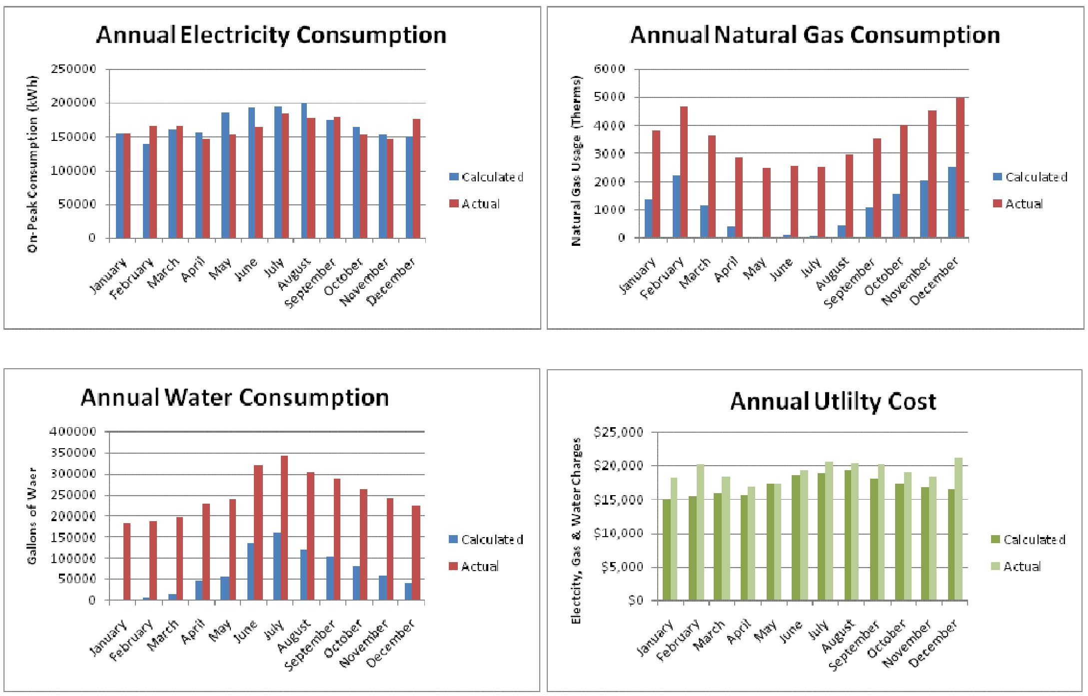

Figure 3-9: Annual Energy Consumption for Utilities and Total Utility Cost

Another observation made is the fluidity between the water and natural gas consumption. Since the calculated values are based on actual output, a mechanical system's effect on annual usage becomes apparent. A ramping effect occurs for both utilities, showing peak and off-peak values, eventually equaling zero.

The annual utility cost, excluding the added actual cost for Devon Seafood restaurant, can also be found in Figure 3-9. While calculated mechanical cost is typically lower than actual cost, a bigger gap will occur when Devon's usage values are added. However, a similar pattern between the peaks and dips does emerge after further investigation. This brings more validity to the accurate model's ability to correctly replicate the current system.

Another way the building's mechanical system can be evaluated for efficiency is though US Green Building Council (USGBC) current LEED-NC rating system. The LEED rating system is broken down into six sections including:

- Sustainable Sites
- Water Efficiency
- Energy & Atmosphere
- Materials & Resources
- Indoor Environment Quality
- Innovation & Design Process

Not every section is related to the mechanical systems; these include Sustainable Sites, Materials & Resources, and Innovation & Design process. The other three sections are closely related. Broken down by the three sections below, an evaluation of Hershey's Press Building currently as well as a comparison to another base building will be evaluated. The final LEED-NC worksheet can be found in Appendix D, with a numerical list of the possible points that could possibly be awarded to the Hershey Press Building and its mechanical system.

Section 1 – Water Efficiency

During the renovation in 2005, no immediate impacts were made towards water efficiency. The site itself has minimal landscaping, none of which seen a reduction in water efficient landscaping was made. The wastewater also has no significant use. Even the water reductions within the plumbing system have not been significant.

Section 2 – Energy and Atmosphere

One of the prerequisites, commissioning, was performed by the mechanical contractor. The Hershey Press Building, analyzed an ASHRAE 90.1-2007 Standard base building (System 3 – Packaged Rooftop Air-Conditioner with Fossil Fuel Furnace) , is 17.2% more efficient, awarding the building 4 LEED points, seen in Table 3-. On-site renewable energy, 3rd party commissioning, and green power were areas in which no points were award. Although, the lack of refrigerants within the mechanical system coupled with the measurement and verification performed, each earned the Press Building some additional points.

Table 3-7: Hershey Press Building Comparison to ASHRAE 90.1-2007 Base Building

Hershey Press Building LEED Anaylsis ASHRAE 90.1-2007 Base Building Comparison				
Direction	Cooling BTUh	Cooling Tons	Heating BTUh	Electric (kWH)
Base - North	2,436,359	259	4,089,000	2,445,111
Base - East	2,262,883	240	4,125,300	2,265,074
Base - South	2,434,750	259	4,472,100	2,595,119
Base - West	2,250,988	242	4,453,600	2,423,715
Base Average	2,346,245	250	4,285,000	2,432,255
Actual	2,037,029	208	777,648	2,014,881
Energy Cost Savings				17.2%

Section 3 – Indoor Environmental Quality

The ventilation was over estimated compared to ASHRAE Standard 62.1-2007; therefore, qualified for Credit 2 for Increased Ventilation. Other indoor environmental quality points the Press Building received include the controllability of systems, thermal comfort design and verification. The eighth credit, Daylight & Views, did not apply since only 52% of the spaces had exterior windows within them.

While many of sections do not relate directly to mechanical, further research would need to occur in order to accurately fill in the check list. While the construction occurred without the LEED mentality, an addition of more points is highly unlikely. If the Press Building would undergo another renovation in the future, it would only take a few alterations to certify the building.

After all sections were carefully reviewed for possible applications to this 1915 building, the final credits for each section could be tallied. Below, in Table 3-8, shows the LEED-NCv2.2 Certification Checklist summary.

Table 3-8: Hershey Press Building LEED-NCv2.2- Certification Checklist Summary

Hershey Press Building LEED Anaylsis Certification Checklist Summary							
	Sustainable Sites	Water Eifficiency	Energy and Atmosphere	Materials and Resources	Indoor Enviroment Qualtiy	LEED Innovation Credits	Total
Yes	0	0	6	0	4	0	10
Maybe	14	0	0	10	5	5	34
No	0	5	11	3	6	0	25
Total	14	5	17	13	15	5	

Notice, that there are 10 definite points and 34 possible. If only 47% of the maybes are indeed points, a "Certified" Certification could be awarded for a minimum of 26 points and valid proof and paperwork.

Overall, to become certified in LEED, it is necessary to start with that decision in mind and work towards that goal. For future renovations, the Hershey Press Building would have a great start, with 10 points, towards a LEED certification.

The Evaluation

The Hershey Press Building has gone through an extensive design process and energy analysis. The mechanical design was chosen based on many factors, including system control in multiple zones, integration of the structural, mechanical and architectural systems, as well as energy efficiency and life cycle cost. Overall, the choice for water source heat pumps was an energy-efficient choice, taking advantage of the large 3-8' high plenum spaces. While the McClure Company chose an extensive, logical design, there are still some alternatives to be discussed. These include strategies to optimize first cost, construction cost, and overall, energy lifecycle costs.

From a renovation standpoint, the Hershey Press Building was a large demolition "gut" of the interior spaces of the building, leaving on the core and shell to remain. With limited shaft and mechanical room space, designers needed to choose an efficient design with minimum duct space.

Using energy recovery ventilators as dedicated outside air units, the shafts provide the vertical space necessary for ventilation air to be distributed to each floor. An enthalpy wheel also improves the efficiency of keeping the ambient temperature necessary required for the plenum. Once the air is blown into the open plenum, the ventilations air mixes with the return air that flow through the grilles in the ceiling through negative pressurized plenum. Hypothetically, the two streams are mixed and are drawn through the heat pumps. While it becomes hard to prove if the actual adequate ventilation is being distributed to each space, a computational fluid dynamics model could be created. With this tool, a model could be created of the plenum space to see if the system is working effectively.

The heat pumps, one in each zone, provide thermal control and comfort for variances in occupancy and schedule. A difficult aspect of the current design is maintenance and filer changes. With the heat pumps located sporadically around the building, it could become difficult to locate and access each heat pump easily. While much of the design allows for access door and removable ceiling tiles, an overall maintenance and filter change plan could be created for the entire building, once the Devon Seafood space's design is finalized. With this plan, preventative care and increased indoor air quality can be met for each of the 94 heat pumps.

The two-pipe heat pump water loop provides the perfect heat absorption/rejection mechanism necessary for the refrigeration cycle for each heat pump. The loop is kept at a temperature necessary for the loop by a natural gas boiler and fluid cooler. The small pipes are also run through the small vertical shafts between floors. One possible evaluation for improvement is the control sequence between the pumps and the heat pumps. The pumps are utilized at full output continuously. If the pumps could be ramped back by a variable frequency drive while reconfiguring each controller for the heat pump terminal units, an efficient pumping system could be satisfied. This could lead to potential energy cost savings.

Another positive design principal was the recovery of the rejected walk-in freezer heat from each of Devon Seafood's walk-in coolers. This provides a helpful boost to the heat pump loop's temperature during the winter months. Harvesting this heat in the summer, however, could decrease the fluid cooler's ability to cool the loop to the necessary temperature. In order to improve this design, special consideration to cost and benefit would have to be considered to take off the walk-in freezers rejected heat off the loop and utilize more efficiently somewhere else in the design.

Fans and make-up air units are also used to exhaust both kitchen spaces. The make-up air unit supplies the air each exhaust fan removes from the space. The unit also requires the conditioned air to provide back to the space, relying on gas heat and economizer cooling to temperate the incoming air. This process could be improved by recovering the heat from the exhaust and replacing back into the make-up unit, similar to the energy recovery ventilator. Through further investigation, a cost saving and a more thermally comfortable scenario could be developed.

Overall, the system at Hershey Press building's mechanical design met objectives while not breaking the budget. Through a few more possible design alternatives, the Hershey Press Building could improve their indoor air quality, thermal comfort of kitchen zones while maximizing energy efficiency, energy usage.

References

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

ANSI/ASHRAE/IENSA, 2007, Standard 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Buildings. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta, GA, 2007.

LEED. 2005, LEED 2005 Green Building Rating System For New Construction & Major Renovations. Leadership in Energy & Environmental Design, Washington, DC. 2005.

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.

Appendix A – Equipment Schedules
Appendix B – Valve and Damper Schedule
Appendix C – Utility Analysis
Appendix D – LEED Analysis

Appendix A – Equipment Schedules

Energy Recovery Ventilator	Manufacturer/ Series	Supply Fan			Exhaust Fan			Summer Conditions		Winter Condtitions		Electrical Data		
		CFM	ESP (in wc)	HP	CFM	ESP (in wc)	HP	EAT DB/WB	LAT DB/WB	EAT DB/WB	LAT DB/WB	Volts/Ph	MCA	MOCP
ERV-401	Greenheck ERV582-H	9,000	1.2	7.5	8,100	1.0	5	SA: 92/74 EA: 75/62	SA: 80/66 EA: 89/72	SA: 0/0 EA: 72/56	SA: 52/44 EA: 14/13	460/3	24	30
ERV-402	Greenheck ERV582-H	9,600	1.25	7.5	8,700	1.0	7.5	SA: 92/74 EA: 75/62	SA: 80/66 EA: 89/72	SA: 0/0 EA: 72/56	SA: 52/44 EA: 14/13	460/3	27	35

Make-Up Air Unit	Manufacturer/ Series	Capacity		Fan Data		Direct Fired Natural Gas					Electrical
		Total CFM	Min CFM	Ext. S.P.	HP	Output MBH	Input MBH	Inlet Press.	EAT	LAT	Volts/Ph
MUA-100	Captiveaire A3-D750-G18	7,000	7,000	1.25"	5	705	521.6	11"WC	0	65	460/3
MUA-101	Greenheck DG-118-H30	9,500	9,500	0.75"	7.5	672.5	730.9	11"WC	0	65	460/3

Boiler	Manufacturer/ Series	Capacity				Natural Gas Input		Electrical Data	
		HP	MBH	GPM	Efficiency	PSI	MBH	Volts/Ph	Amps
B-001,002,003	Patterson-Kelly MACH C-450	12.4	414	40	80	0.5	450	120/1	5

Closed Loop Fluid Cooler	Manufacturer/ Series	Capacity				Electrical Data	
		GPM	EWT	LWT	EAT	Volts/Ph	HP
CT-001	Baltimore AirCoil FXV-641	690	100	90	78	460/3	(2) 15

Pumps	Manufacturer/ Series	Capacity			Motor		Electrical
		GPM	Heat (ft)	Temp	RPM	HP	Volts/Ph
HPWP-001,002	Bell and Gosset 4GB	690	112	100	1750	30	460/3
P-003	Taco	2	21	120	3250	1/8	115/1

Fans	Manufacturer/ Series	Capacity		Motor			Electrical
		CFM	ESP (in wc)	HP	RPM	Drive	Volts/Ph
F-001	Greenheck BSQ-90	650	0.4	0.25	1,435	Belt	120/1
F-002	Greenheck BSQ-120	1,200	0.4	0.25	1,300	Belt	120/1
F-003	Captiveaire B127CARM	8,625	2	5.00	939	Belt	460/3
F-004	Greenheck CWB-300HP	6,500	1.7	3	883	Belt	460/3
F-005	Greenheck CWB-141HP	900	1.7	0.50	1,811	Belt	460/3
F-006	Greenheck CWB-180	2,700	1.7	1.50	1,313	Belt	460/3
F-007	Greenheck SQ-65	100	0.3	1/30	1,550	Belt	115/1

Electric Heaters	Manufacturer/ Series	Capacity			Electrical
		CFM	kW	MBH	Volts/Ph
WH-001,002,003, 101, 301, 302, 303	BERCO FRC-4827	100	4.8	16,382	277/1
WIH-301, 302, 303, 304, 305, 306, 307	BERCO SRA-1527	100	1.5	5,100	277/1
UH-001,002	BERCO HUH-524TA	270	2.5	8,533	208/1

Water Source Heat Pumps	Manufacturer/ Series	Fan Section			Coil Data		Cooling		Heating	Performance		Electrical	
		CFM	ESP (in wc)	Speed	GPM	WPD (ft)	Total MBH	Sens. MBH	Total MBH	Min COP	Min EER	Volts/Ph	MCA
HP-001, 128, 129, 211, 218, 308, 326, 332	FLORIDA EM-7	300	0.4	M	1.9	3.7	7.5	5.9	9	4.7	12.3	208/1	4.8
HP-319, 331	FLORIDA EM-9	350	0.4	M	2.4	6.8	9.1	7.4	11.7	4.3	12.5	208/1	6
HP-101-108, 118, 119, 222	FLORIDA EM-12	400	0.4	M	3	11	11.5	9	13.1	3.8	11.4	208/1	7.2
HP-002, 125, 201, 208, 210, 213, 215, 216, 226, 227, 230, 306, 315, 316, 317, 324, 330, 334	FLORIDA EM-15	500	0.4	M	3.8	12.5	14.8	11.5	18	3.9	11.6	208/1	9.5
HP-113, 203, 206, 220, 310, 311, 322, 327, 333	FLORIDA EM-18	650	0.4	M	4.7	19.4	18.5	14.4	22.4	4.6	13.5	208/1	13.1
HP-121, 130, 205, 217, 223, 301, 303, 305, 314, 328	FLORIDA EM-24	850	0.4	M	5.8	10.3	24	18.7	27	4.6	14	208/1	13.6
HP-224, 225, 320, 321, 323	FLORIDA EM-28	950	0.4	M	7	13.6	28	21.8	30	4.3	14.2	460/3	6.3
HP-114, 115, 209, 212, 228, 229	FLORIDA EM-31	1,000	0.4	M	8.1	7.2	32	25	37.5	4.2	14	460/3	7.3
HP-122, 116, 312	FLORIDA EM-36	1,200	0.4	M	8.6	9.5	35	27.3	37.5	4.2	14	460/3	8.3
HP-202, 204, 207, 214, 219, 221, 302, 307, 325	FLORIDA EM-41	1,150	0.4	M	9.8	12.4	39.5	30.8	44.7	4	13.2	460/3	9.8
HP-329	FLORIDA EM-42	1,500	0.4	M	10.4	14	42	32.8	45.8	4	13.2	460/3	9
HP-117	FLORIDA EM-48	1,800	0.4	M	12.3	10.7	39	38.2	52.6	4.6	12.2	460/3	9.1
HP-112, 123, 304, 313, 318	FLORIDA EM-60	2,000	0.4	M	14.6	10.2	60	46.8	72.6	4.2	13	460/3	10.9
HP-124, 309	FLORIDA EM-70	2,200	0.4	M	17.8	18.5	70	54.6	75.4	4.3	14.5	460/3	13.2
HP-111, 120, 126, 127	FLORIDA EM-96	2,800	0.8	M	23.4	18.8	96	74.9	99.3	4.7	13.5	460/3	17.6
HP-110	FLORIDA EM-120	4,000	0.7	M	30	15.1	123	101.3	132.8	5	14.3	460/3	20.5
HP-109	FLORIDA EM-170	6,000	1.1	M	45	24.5	180	140.4	196.9	4.2	14.4	460/3	35.8

Appendix B – Valve & Damper Schedule

Hershey Press Building Valve Schedule

UNIT	FUNCTION	VALVE TYPE	LINE SIZE	VALVE SIZE	GPM	Cv	psi DP	CLOSE OFF PRESSURE	CONNECTION
CV-1	B-001 Isoation	2-Way, 2-Pos.	2.5"	2.5"	40	196	0.04	50 psi	Flanged
CV-2	B-002 Isolation	2-Way, 2-Pos.	2.5"	2.5"	40	196	0.04	50 psi	Flanged
CV-3	B-003 Isolation	2-Way, 2-Pos.	2.5"	2.5"	40	196	0.04	50 psi	Flanged
CV-4	CT-001 Bypass	2-Way, 2-Pos.	6"	5"	690	1022	0.46	50 psi	Flanged
CV-5	CT-001 Isolation	2-Way, 2-Pos.	6"	5"	690	1022	0.46	50 psi	Flanged
CV-6	CT-001 MUA Isolation	2-Way, 2-Pos.	6"	5"	690	1022	0.46	50 psi	Flanged

Hershey Press Building Damper Schedule

UNIT	FUNCTION	SIZE	Seals	ACTUATION
D-1	Boiler Rm Intake	16" W x 24" H	No	120 VAC, 2-Pos., N.C. / Belimo # LF120-S-US
D-2	Electric Rm Intake	16" W x 24" H	No	120 VAC, 2-Pos., N.C. / Belimo # LF120-S-US

Appendix C – Utility Analysis

Hershey Press Building Annual Energy Consumption and Operating Costs: Calculated													
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	$13,730	$13,072	$14,657	$14,800	$16,939	$17,595	$17,880	$18,001	$16,297	$15,204	$14,178	$13,581	$185,934
Gas													
	January	February	March	April	May	June	July	August	September	October	November	December	Total
MCF	136	220	114	38	0	6	4	45	106	154	204	250	1277
$/MCF	$10.28	$10.66	$10.66	$10.66	$12.50	$12.50	$12.50	$12.50	$10.66	$10.66	$10.66	$10.28	$12.50
Cost	$1,397	$2,342	$1,215	$407	$0	$75	$46	$567	$1,130	$1,642	$2,175	$2,567	$13,563
Water													
	January	February	March	April	May	June	July	August	September	October	November	December	Total
Gallons	0	5,000	14,000	44,500	56,000	135,500	158,000	118,000	103,000	80,000	58,000	38,500	810,500
$/Gallon	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01
Cost	$0	$34	$96	$293	$365	$845	$975	$742	$649	$496	$377	$253	$5,125
Total Cost	$15,126	$15,448	$15,969	$15,500	$17,304	$18,515	$18,901	$19,310	$18,076	$17,341	$16,730	$16,402	$204,622

Hershey Press Building Annual Energy Consumption and Operating Costs: Actual													
Electricity													
	January	February	March	April	May	June	July	August	September	October	November	December	Total
Demand kW	362	380	324	340	345	388	382	385	375	371	307	376	382
Cons. kWh	154,200	165,600	165,600	145,800	153,000	163,800	184,200	177,600	178,800	152,400	145,800	175,800	1,962,600
Cost	$13,101	$13,953	$13,203	$12,357	$12,809	$14,268	$15,311	$14,773	$14,710	$13,203	$12,011	$14,551	$164,249
Gas													
	January	February	March	April	May	June	July	August	September	October	November	December	Total
MCF	383	467	361	285	247	253	251	292	353	401	451	497	4241
$/MCF	$10.28	$10.66	$10.66	$10.66	$12.50	$12.50	$12.50	$12.50	$10.66	$10.66	$10.66	$10.28	$12.50
Cost	$3,935	$4,975	$3,849	$3,041	$3,086	$3,161	$3,132	$3,654	$3,763	$4,275	$4,808	$5,105	$46,784
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	3,006,500
$/Gallon	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01
Cost	$1,257	$1,283	$1,355	$1,496	$1,556	$1,985	$2,104	$1,893	$1,802	$1,631	$1,567	$1,458	$19,387
Total Cost	$18,293	$20,211	$18,407	$16,894	$17,452	$19,414	$20,548	$20,320	$20,275	$19,108	$18,385	$21,114	$230,421

Appendix D – LEED Analysis

LEED for New Construction v 2.2
Registered Project Checklist

Project Name: Hershey Press Building

Project Address: 27 West Chocolate Avenue, Hershey, PA 17033

Yes	?	No			
10	34	25	**Project Totals** (Pre-Certification Estimates)		69 Points
			Certified: 26-32 points **Silver**: 33-38 points **Gold**: 39-51 points **Platinum**: 52-69 points		

Yes	?	No			
0	14	0	**Sustainable Sites**		14 Points
Yes			Prereq 1	**Construction Activity Pollution Prevention**	Required
0	1	0	Credit 1	**Site Selection**	1
0	1	0	Credit 2	**Development Density & Community Connectivity**	1
0	1	0	Credit 3	**Brownfield Redevelopment**	1
0	1	0	Credit 4.1	**Alternative Transportation**, Public Transportation	1
0	1	0	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
0	1	0	Credit 4.3	**Alternative Transportation**, Low-Emitting & Fuel Efficient Vehicles	1
0	1	0	Credit 4.4	**Alternative Transportation**, Parking Capacity	1
0	1	0	Credit 5.1	**Site Development**, Protect or Restore Habitat	1
0	1	0	Credit 5.2	**Site Development**, Maximize Open Space	1
0	1	0	Credit 6.1	**Stormwater Design**, Quantity Control	1
0	1	0	Credit 6.2	**Stormwater Design**, Quality Control	1
0	1	0	Credit 7.1	**Heat Island Effect**, Non-Roof	1
0	1	0	Credit 7.2	**Heat Island Effect**, Roof	1
0	1	0	Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
0	0	5	**Water Efficiency**		5 Points
0	0	1	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
0	0	1	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
0	0	1	Credit 2	**Innovative Wastewater Technologies**	1
0	0	1	Credit 3.1	**Water Use Reduction**, 20% Reduction	1
0	0	1	Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Powered by Adobe® LiveCycle™

Last Modified: May 2008 1 of 4

LEED for New Construction v 2.2
Registered Project Checklist

Yes	?	No				
6	0	11	Energy & Atmosphere			17 Points
Yes			Prereq 1	**Fundamental Commissioning of the Building Energy Systems**		Required
Yes			Prereq 1	**Minimum Energy Performance**		Required
Yes			Prereq 1	**Fundamental Refrigerant Management**		Required

***Note for EAc1:** All LEED for New Construction projects registered after June 26, 2007 are required to achieve at least two (2) points.

Yes	?	No				
4	0	6	Credit 1	**Optimize Energy Performance**		1 to 10
				Credit 1.1	10.5% New Buildings / 3.5% Existing Building Renovations	1
				Credit 1.2	14% New Buildings / 7% Existing Building Renovations	2
				Credit 1.3	17.5% New Buildings / 10.5% Existing Building Renovations	3
			-->	Credit 1.4	21% New Buildings / 14% Existing Building Renovations	4
				Credit 1.5	24.5% New Buildings / 17.5% Existing Building Renovations	5
				Credit 1.6	28% New Buildings / 21% Existing Building Renovations	6
				Credit 1.7	31.5% New Buildings / 24.5% Existing Building Renovations	7
				Credit 1.8	35% New Buildings / 28% Existing Building Renovations	8
				Credit 1.9	38.5% New Buildings / 31.5% Existing Building Renovations	9
				Credit 1.10	42% New Buildings / 35% Existing Building Renovations	10
0	0	3	Credit 2	**On-Site Renewable Energy**		1 to 3
				Credit 2.1	2.5% Renewable Energy	1
				Credit 2.2	7.5% Renewable Energy	2
				Credit 2.3	12.5% Renewable Energy	3
0	0	1	Credit 3	**Enhanced Commissioning**		1
1	0	0	Credit 4	**Enhanced Refrigerant Management**		1
1	0	0	Credit 5	**Measurement & Verification**		1
0	0	1	Credit 6	**Green Power**		1

LEED for New Construction v 2.2

Registered Project Checklist

Yes	?	No			
0	10	3	**Materials & Resources**		13 Points
Yes			Prereq 1	**Storage & Collection of Recyclables**	Required
0	0	1	Credit 1.1	**Building Reuse,** Maintain 75% of Existing Walls, Floors & Roof	1
0	0	1	Credit 1.2	**Building Reuse,** Maintain 95% of Existing Walls, Floors & Roof	1
0	0	1	Credit 1.3	**Building Reuse,** Maintain 50% of Interior Non-Structural Elements	1
0	1	0	Credit 2.1	**Construction Waste Management,** Divert 50% from Disposal	1
0	1	0	Credit 2.2	**Construction Waste Management,** Divert 75% from Disposal	1
0	1	0	Credit 3.1	**Materials Reuse,** 5%	1
0	1	0	Credit 3.2	**Materials Reuse,** 10%	1
0	1	0	Credit 4.1	**Recycled Content,** 10% (post-consumer + 1/2 pre-consumer)	1
0	1	0	Credit 4.2	**Recycled Content,** 20% (post-consumer + 1/2 pre-consumer)	1
0	1	0	Credit 5.1	**Regional Materials,** 10% Extracted, Processed & Manufactured	1
0	1	0	Credit 5.2	**Regional Materials,** 20% Extracted, Processed & Manufactured	1
0	1	0	Credit 6	**Rapidly Renewable Materials**	1
0	1	0	Credit 7	**Certified Wood**	1

Yes	?	No			
4	5	6	**Indoor Environmental Quality**		15 Points
Yes			Prereq 1	**Minimum IAQ Performance**	Required
Yes			Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
0	0	1	Credit 1	**Outdoor Air Delivery Monitoring**	1
1	0	0	Credit 2	**Increased Ventilation**	1
0	0	1	Credit 3.1	**Construction IAQ Management Plan,** During Construction	1
0	0	1	Credit 3.2	**Construction IAQ Management Plan,** Before Occupancy	1
0	1	0	Credit 4.1	**Low-Emitting Materials,** Adhesives & Sealants	1
0	1	0	Credit 4.2	**Low-Emitting Materials,** Paints & Coatings	1
0	1	0	Credit 4.3	**Low-Emitting Materials,** Carpet Systems	1
0	1	0	Credit 4.4	**Low-Emitting Materials,** Composite Wood & Agrifiber Products	1
0	1	0	Credit 5	**Indoor Chemical & Pollutant Source Control**	1
0	0	1	Credit 6.1	**Controllability of Systems,** Lighting	1
1	0	0	Credit 6.2	**Controllability of Systems,** Thermal Comfort	1
1	0	0	Credit 7.1	**Thermal Comfort,** Design	1
1	0	0	Credit 7.2	**Thermal Comfort,** Verification	1
0	0	1	Credit 8.1	**Daylight & Views,** Daylight 75% of Spaces	1
0	0	1	Credit 8.2	**Daylight & Views,** Views for 90% of Spaces	1

LEED for New Construction v 2.2
Registered Project Checklist

Yes	?	No			
0	5	0	**Innovation & Design Process**		5 Points
0	1	0	Credit 1.1	**Innovation in Design:** Provide Specific Title	1
0	1	0	Credit 1.2	**Innovation in Design:** Provide Specific Title	1
0	1	0	Credit 1.3	**Innovation in Design:** Provide Specific Title	1
0	1	0	Credit 1.4	**Innovation in Design:** Provide Specific Title	1
0	1	0	Credit 2	**LEED® Accredited Professional**	1