Technical Assignment I

ASHRAE Standard 62.1-2007 & 90.1-2007

The Hershey Press Building
Hershey, PA

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Executive Summary

The Hershey Press Building was built in 1915 as a printing press facility. Since then, the building has been renovated numerous times, to the final state it is in today. Four major tenants call this place home, including Hershey Entertainment and Resorts Office Headquarters, Houlihan's restaurant, Jack Gaughen Realty Offices, and Devon Seafood Grill restaurant.

In terms of the energy efficiency and the proper indoor air quality, it is necessary to check the building for its ability to comply with ASHRAE 62.1-2007 *Ventilation for Acceptable Air Qualit*y standards as well as ASHRAE 90.1-2007 *Energy Standard for Buildings Except Low-Rise Residential Building* standards.

Two main sections of ASHRAE 62.1-2007 were evaluated. Section 5, *Systems and Equipment*, covered many requirements in order for the indoor air quality to be safe and healthy for inhabitants. Detailed for that section are the major points that are associated with the Hershey Press Building. Because of the nonconventional mechanical system utilized in this space, it became necessary to ensure that most of the points were met. You will find arguably, that the Press Building met all of the standards required, those that were applicable, in this section.

Section 6 of ASHRAE 62.1-2007 discusses and calculates the minimum outside air requirements for the spaces. Based on occupancy, population, and area, the minimum ventilation rates were calculated and compared to the original minimum outside air volumetric flow rate found. The results proved that indeed the Hershey Press Building had the proper amount of outside air being distributed to the system.

Seven sections of ASHRAE Standard 90.1-2007 were also evaluated. The building envelope did not meet all the standards required by this standard. , namely the walls and glazing fell short of expectations. In the heating, ventilating and air conditioning section, it meets most of the standards except for the heat rejection equipment, the fluid cooler, needs to be more efficient in order to meet the standard. The service water heating, gas-fired domestic water heaters of the space met the criterion of this section. As did the power requirements in the power section. Section nine, lighting, was one section that the Hershey Press Building failed to meet miserably. The power lighting density for the facility extremely surpassed the maximum allowable power density, and therefore failed the building's ability to be lighting efficient. In the other equipment section, the press building redeemed itself to an extent, by meeting all the efficiencies in the motor requirements. Finally, the eleventh section will be discussed in the next technical assignment.

Overall, the Hershey Press Building should be rated satififsfactory, but needs improvement, in the ASHRAE Standard 62.1 and 90.1 compliancy. With more renovations and efficiency equipment choices, the Press Building could improve its current situation to be a building that boasts acceptable indoor air quality and energy efficiency, according to these standards.

ASHRAE Standard 62.1 Summary

According to the ASHRAE Standard 62.1 - 2007, the purpose of the standard "is to specify minimum ventilation rates and indoor air quality that will be acceptable to human occupants and are intended to minimize the potential for adverse health effects." Its purpose, more specifically related to a renovation, is to guide designers in the improvements of indoor air quality in existing buildings.

More specifically related the Hershey Press Building renovation, the more modern aesthetics will not be the only impact; indoor air quality will be a not –so-noticeable, but integral design decision in the health of building and its tenants. Applied directly to our case, this standard will allow for a more beneficial environment for tenants, regardless of the previous mechanical design.

ASHRAE Standard 62.1 is broken down into nine separate sections, ranging from the purpose and scope to outdoor air quality and references. Two sections in particular, *Systems and Equipment* and *Procedures*, are essential in accessing the buildings performance in meeting the standard's requirements.

Procedures, detailed in Section 6, will focus on the measures and equations, depending on which procedure, IAQ or Ventilation Rate must be followed. *Systems and Equipment,* Section 5 in the text, discusses the variety of components and requirements for equipment and air/water systems.

Section 5 – Systems and Equipment

Section 5.1 discusses the use of Natural Ventilation in the building design. The original design, dating back to 1915, relied on operable windows to allow natural ventilation to exist. Since then, the windows have been replaced with ¼" glazed, 6x6-grid picture windows that are inoperable, therefore eliminating natural ventilation from occurring.

The next section, Section 5.2 Ventilation Air Distribution, focuses on air balancing and plenum systems. Since an energy ventilator is being utilized, the minimum ventilation air flows, 9,600 CFM, must be supplied at all times and documented as such. Proper control and dampers on the energy recovery ventilator itself will be utilized to measure and verify the proper flow rate of ventilation air is being delivered to the ceiling plenum.

Since the water-source heat pumps are serving as terminal units in the ceiling plenum, the next sub-section on *Plenum Systems* becomes very relevant. The standard requires that each space is being properly ventilated with the required minimum ventilation air flow. More specifically, you can easily satisfy this requirement by directly connecting ventilation air ducts to the heat pumps themselves. However, this was the not the case.

The plenum in our case is being pumped with outside air from the ERV supply trunk. This outside air is mixing with the return air being drawn through return ceiling grilles by the negative pressure in the plenum created by the heat pumps. The mixed air, of uncertain ratio of outside air and room air, is then being drawn through the heat pumps and being supplied to the spaces.

The problem is that one cannot guarantee, beyond a reasonable doubt, that the minimum outside air requirement to each space is being met by this heat pump design. Location of return grilles versus the taps off the supply air trunk versus the location of the heat pumps, all become variables of this mixed air ratio problem. For example, if an outside air supply duct is closer to one heat pump then another, it is possible that the majority of the outside air will be drawn through the one heat pump and not the other. Conversely, it is also possible that a return grille located too close to a heat pump unit may lead to 100% re-circulated return air being supplied to that heat pump zone. Recirculation of room air is where an indoor air quality issue would most definitely occur.

Some may argue that the negative pressure created by the heat pump will draw a certain percentage of outside air to the unit. This unequal “pull” of all the units together at one time will allow the minimum outside air will distribute itself, in the necessary fashion, to meet the minimum requirements. However, others will argue that there are too many variables present that would hinder this system to meet the ventilation requirements. No matter which end of the spectrum seems to make the most sense, without doing a computational fluid analysis, neither can be proved nor disproved.

One characteristic that works in the Press Building’s favor is that many of the spaces are open to one another. This leads to better mixing and most importantly, you aren’t “starving” or “supplementing” numerous zones with ventilation.

Section 5.3, *Exhaust Duct Location*, requires exhausts ducts that possess potentially harmful contaminants should be negatively pressurized to prevent contamination of supply, return or outdoor air ducts or plenums. While the exhaust ducts returning to the ERV unit do not specifically contain harmful contaminants, they are however negatively pressurized by design. The ERV is supplying 9,600 CFM of outside air and it is drawing back 8,700 CFM of exhaust air, leading to a negative exhaust duct.

Ventilation System Controls, Section 5.4, requires the ERV unit to have proper controls of fans and dampers, in order for the system to maintain the minimum outside air ventilation requirements. This also means the system must be able to be tested and provide the same requirements during emergency situations.

The next Section 5.5, *Airstream Surfaces*, requires that all surfaces in equipment and ducts be resistant to mold growth and erosion. On the equipment side, this information can often be found in the specification materials, in which ERV-402 was compliant with this standard by having 18” galvanized steel weather-exposed panels. For the duct requirements, all ductwork used is sheet metal.

Section 5.6, *Outdoor Air Intakes*, requires the location of the roof-mounted ERV unit’s outdoor air intake that be at least 1 foot from away from the roof’s surface (found in Table 5-1). Also, significantly contaminated exhausts must be 15 feet away from indoor air intakes, which is being met by a 45 foot distance between ERV-401's intake and ERV 402's exhaust and vice versa.

Rain entrainment is also being met by at the ERV's weather hood that has a louvered design and moisture eliminator and is tested with AMCA Standard 500-L to prevent water penetration up to 3 in/hr at 29 mph. Bird screens are also incorporated into the ERV's intake hood design. The ERV is also set up on a curb to ensure that snow entrainment requirements, as well as proper outside air intake and roof distances, are being met.

In order for to meet Section 5.7, *Local Capture of Contaminants*, the building's exhaust devices (including grease exhausts and hoods) are all directly ducted to the building exterior through sidewall penetrations. As are the gas-fired combustion boilers located in the basement, therefore meeting section 5.8, *Combustion Air.*

Particulate Matter Removal, Section 5.9, requires filters to be rated 6 or above to be placed upstream of all cooling coils and wetted surfaces. The ERV units have supply and exhaust air filters that are 2-inch thick pleated fiberglass and 30% efficient and tested to meet UL Class 2. There are also 1" filters located in each of the heat pumps.

Since there is no direct dehumidification system, Section 5.10 *Dehumidification Systems* and Section 5.13 *Humidifiers and Water-Spray Systems* do not apply.

Drain Pans, Section 5.11, require drains and/or pan to have seals, be sloped, and have outlets at the lowest location. Each of the heat pumps has condensate locations that need to be sloped and have traps to prevent airflow through drain lines.

Section 5.12, *Finned-Tube Coils and Heat Exchangers*, requires that coils be 18" from access space, which aligns with the heat pumps coil spacing, which is 20" from the access door location.

The next standard, Section 5.14, *Access for Inspection, Cleaning and Maintenance,* can often lead to disgruntled service technicians and systems that do not function properly. Clearances for all equipment meet the minimum clearances are easily accessible. Heat pumps not located above acoustical ceiling tiles will have access panels in the dry-wall ceiling in order for routine maintenance and annual filter changes to occur.

Building Envelope and Interior Surfaces, Section 5.15, ensures that the building is water-tight from precipitation and liquid water. For example, the brick façade is protected by a plastic membrane funnel out to weep holes located at the base of the building. Also, penetrations and seams in the building were caulked and lined to prevent water entrance.

The Hershey Press Building does not have an attached parking garage, therefore Section 5.16, *Buildings with Attached Parking Garages*, does not apply.

Section 5.17 *Air Classification and Recirculation*, rates return air with an Air Class rating. Since all of the grease hood and exhausts have their own dedicated exhaust systems, this does not pose problem being and Air Class rating 4. Also, the relief exhausts grilles have been placed in proximity to odorous, inappropriate circulation air, in order to prevent the mixing of these air streams with the air supplied to the space.

The final section, Section 5.18 *Requirements for Buildings Containing Environmental Tobacco Smoke (ETS) Management Areas and ETS-Free Areas*, does not apply since the owner stated that his facility will be smoke-free.

Section 6 – Procedures

Standard 62.1-2007 has two choices for designing ventilation systems for a building: the Ventilation Rate Procedure and the Indoor Air Quality (IAQ) Procedure. In the case of the Hershey Press Building, the Ventilation Rate Procedure was originally used, as well as the International Mechanical Code, to specify the minimum outside air requirements.

When analyzing the existing system to ensure the minimum ventilation CFM was met, it is necessary to use the calculations outlined below to arrive at a reasonable assessment of the minim airflow required.

6.2.2.1 Breathing Zone Outdoor Airflow (V_{bz})

$$V_{bz} = R_p P_z + R_a A_z \qquad \text{Eqn. (6-1)}$$

Where: V_{bz} = the breathing zone outdoor airflow (CFM)

R_p = the outdoor airflow rate required per person as determined from Table 6-1 (CFM/person)

P_z = zone population: the largest number of people expected to occupy the zone, either specified or estimated based on floor average area from Table 6-1 (person/people)

R_a = the outdoor airflow rate required per unit area as determined from Table 6-1 (CFM/SF)

A_z = the zone floor area: the net occupiable floor area of the zone (SF)

6.2.2.2 Zone Air Distribution Effectiveness (E_z)

$$E_z = 1.0 \qquad \text{Table 6-2}$$

The zone air distribution effectiveness shall be determined using Table 6-2. Since the ceiling supply of warm air is less than 15°F above space temperature and ceiling return provided that the 150 fpm supply jet reaches 4.5 ft or more above the floor.

6.2.2.3 Zone Outdoor Airflow (V_{oz})

$V_{oz} = Vb_z / E_z$	Eqn. 6-2

The design zone outdoor airflow (V_{oz}) is the air that must be provided to the zone by the supply air distribution system must be determined from the equation above.

6.2.2.5 Multiple-Zone Recirculating Systems

6.2.5.1 Primary Outdoor Air Fraction (Z_p)

$Z_p = V_{oz} / V_{pz}$	Eqn. 6-5

Where: Z_p = Zone Primary Air Fraction
V_{oz} = Zone Outdoor Airflow, found in 6.2.2.3
V_{bz} = Zone Primary Airflow

6.2.5.2 System Ventilation Efficiency (E_v)

$E_v = 0.84$	Table 6-3

Where: E_v = System Ventilation Efficiency such that E_v =minimum E_{vz}, where E_{vz} is:

$E_v = \min (E_{vz})$	Appendix A

Such that: Evz = Zone Ventilation Efficinecy

$E_{vz} = 1 + V_s – Z_d$	Appendix A

Where: X_s = Average Outdoor Air Fraction (V_{ou} / V_{ps})
Z_d = Discharge Outdoor Air Fraction (V_{oz} / V_{dz})
V_{dz} = VAV Systems only = 0

6.2.5.3 Uncorrected Outdoor Air Intake(V_{ou})

$V_{ou} = D^* S_{all\ zones} * R_p{*}P_z + S_{all\ zones} * R_a * A_z$	Eqn. 6-6

Where V_{ou} = Uncorrected Outdoor Air Intake
D = Occupant Diversity = 1

6.2.5.4 Outdoor Air Intake(V_{ot})

$V_{ot} = V_{ou} / E_v$	Table 6-8

By following these equations, the outdoor air intake flow (V_{ot}) can be determined.

System Analysis

The Hershey Press Building, built in 1915, has evolved throughout the years as an important iconic structure, adorning the beloved Chocolate Avenue in Hershey, Pennsylvania. To the people who know the building, the renovations over the years have changed the function of this building from a printing press to a bakery to a department store, to its final tenants: Hershey Entertainment and Resort Office Building, Houlihan's Restaurant, Jack Gaughen Realty Office, and the upcoming Devon Seafood Grille.

Perhaps the most astonishing feature, often times overlooked, it the building's ability to provide an exoskeleton to the tenants it has seen over the years. The façade, structure, shafts and columns, all attribute to the Hershey Press Building ability to grow within without compromising its original industrial, exterior appearance.

One of the biggest challenges the building has been face with is proper climate control and ventilation for the 75,000 square feet, 3-story building, without compromising space or aesthetics. Ninety-Four water source heat pumps, ceiling mounted, were placed in the extra large plenums created by 15' floor to floor height. Within these plenums, return air and outside are mixed and drawn to the heat pumps, as discussed in Section 5. Two energy recovery ventilators on the roof provide the necessary outside air requirements to all three floors and basement, serving as a sort of dedicated outside air unit for the facility . Exhaust duct, providing relief for the ERV's, are ran through silica gel heat exchangers to temperate the outside air before it is discharged to the plenums. Three natural gas boilers and one closed-loop fluid coolers are used to provide the proper temperature of water in the circulated hydronic loop. Make-up air units and kitchen grease exhausts are used to ensure proper ventilation and exhaust of equipment without cross-contaminating the building's plenums'.

For the ventilation rate analysis, Energy Recovery Ventilator (ERV-402) was used to compare the minimum outdoor air ventilation that was calculated versus what was designed. The ERV serves the first floor only, which houses 3 major tenants' area, as illustratrated in Figure 1-1. All three of the tenant's mechanical systems were designed and occupied at separate times. Currently, two restaurants and a commercial office space occupy the first floor. Two ducts mains from the ERV above, dedicated to outside air and exhaust air, run parallel to all three spaces, branching out to each to serve the plenums with outside and air and exhaust room directly through ceiling exhaust grilles.

This system, ERV-402, was the most important to analyze because of the diversity of the spaces it serves. The second and the third floor have similar occupancies, office space and conference rooms being occupied from 9-5 on weekdays, thus ERV-1 was sized to meet these criteria. However, the first floor was sized prior to the other two tenant's layouts, it was important to ensure the designer allowed enough ventilation air was leftover after the third design was finished, without knowing who the second and third tenants were going to be. There is also a variety of occupancies with varied times of occupancy, that need to be taken into consideration. The first floor also has more complex exhaust and make-up air systems that had to be examined to ensure there was no cross-contamination of grease exhaust and recirculated air.

Figure 1- : Hershey Press Building - First Floor Tenant Spaces being ventilated by ERV-402.

For these reasons, it is necessary to calculate the outside air requirements for the first floor, being served by ERV-402, to ensure the ventilation design used to select the ERV was valid.

Originally, the ventilation rate found during the first tenant fit-out, Houlihan's Restaurant, summed the entire first floor, including the main lobby. By using the International Mechanical Code, 2003, Section 403.3, the designer found a minimum outside air and sized the ERV-402 based on this number. To maintain the first floor at an ambient temperature until the other two tenant fit-out spaces were sold, small heat pumps units were used to maintain 55°F space temperature.

Jack Gaughen, the second tenant fit-out, also used the International Mechanical Code to find the ventilation requirements necessary for the space. Finally, during the summer of 2008, the final tenant fit-out space, Devon Seafood Grille, leased the space and the mechanical design was created, relying on ASHRAE Standard 62.1-2004 for the ventilation design requirements. All three of the original calculations can be found on page 19 in Appendix A – Original O/A Calculations.

In order to check the validity of the original outside air calculations, the first step in examining the ventilation rate procedure was to divide the first floor into zones. Originally, designing the zones by heat pumps seemed like a logical choice. However, after further examination, it became difficult to separate which areas would be served by which heat pumps in large open rooms with more than one heat pump supplying it. It then became critical to zone similar rooms that share the same interior/exterior walls and/or had similar room size and occupancies. For example, dining rooms with multiple heat pumps were all put in the same zone, as were closed in offices in the commercial realty spaces. By doing this, the first floor had 17 zones.

The next step was to sum the occupiable area of each zone as well as count the number of people that will occupy each zone. Finding the amount of people was easy, since the architect specified on the drawings the amount of occupants per area. After adding in a conservative estimate for the kitchen and restaurant staff, there was enough information necessary to perform the ventilation rate procedure.

Standard 62.1 Compliance Results

Using the minimum ventilation rates taken from Table 6-1 in Standard 62.1-2007, the ventilation rates were calculated. In Table 1-1 below, you will find the overall system results. You should also see Appendix B – Required O/A Calculations on page 21 to view the results broken down by space.

Hershey Press Building ERV-402 ASHRAE Standard 62.1-2007 System Final Results									
Calculated Minimum Ventilation				Minimum Outdoor Air Intake Airflow					
System	Floor Area Served (A_s)	Peopulation Served (P_s)	Primary Supply Airflow Rate (V_{psd})	OA Intake Flow Req'd (V_{ot})	OA Intake Req'd Fraction of Primary SA (Y = V_{ou}/E_v)	Ventilation System Efficiency (E_v)	OA per Unit Floor Area (V_{ot}/A_s)	OA per Person (V_{ot}/P_s)	% OA per Design Primary Supply Air (Y_{pd})
ERV-402	20,467	569	40,000	8,298	0.21	0.84	0.41	14.6	21%

Table 1-1: Hershey Press Building Standard 62.1-2007 System Final Results

Notice, that Zone 12 in Appendix B, Devon Seafood's dining room, is hi-lighted in pink. This is because it has the highest *Primary Outside Air Fraction* (Z_p) value. This is largely due to the high concentration of people in a zone that has a marginal supply air volume being served to it. One way of reducing the Z_p value for this zone is to supply more air to the space. While using the *Short-Term Condition* calculation may be another possible way of reducing Z_p, it is not applicable in this case due to the dining room being occupied 12-14 hours a day, thus not being considered short-term.

Although Zone 12, the dining room for Devon Seafood has the maximum value for Z_p, it is important to realize that the rest of the Zp values are close in proximity to one another. In fact, most of the values are in the the 10-20% range. This is quite beneficial for our ERV/heat pump system. As discussed in Section 5, the amount of o/a required to each space is critical to the design. If all the spaces has similar outside air fractions, it is much more likely that each zone will receive an even amount of outside air, thus meeting their zone ventilation requirement. In other words, if all the zones are pulling for relative equal amounts of outside air, there is a greater chance that the ventilation requirements will be met.

One inconsistency that may be found in Appendix B is that a few of the zone efficiencies (E_{vz}) are greater than one. How can efficiency be greater than one? One reason is because a few of these spaces are being over ventilated, being supplied more outside air than what is actually required. Having an abundance of ventilation air isn't' necessarily a bad problem to have. Studies have found that over ventilated spaces have occupants that are less lethargic and more productive. The spaces that have efficiencies greater than one, such as conference rooms, offices, and kitchens, will have occupants that will benefit from the additional ventilation.

After the results were calculated, the data calculated for minimum ventilation was compared to the original calculations made by the designer a few years earlier. See Table 1-2 below for the comparison.

Hershey Press Building ERV-402 ASHRAE Standard 62.1-2007 Calculations			
Calculated Minimum Ventilation		As-Designed Minimum Ventilation	
Tenant	Calculated V_{ot} (CFM)	Orignal Min. O/A (CFM)	Meets Std. 62.1-2007?
Lobby	24	25	YES
Houlihan's	2,975	5,760	YES
Devon Seafood Grill	3,261	3,330	YES
Jack Gaughen Realty	752	1,925	YES
Total	7,011	11,040	YES

Table 1-2: Hershey Press Building Standard 62.1-2007 Compliancy Calculations

The results may not surprise you. All of the original outside air calculations from the three tenant spaces met and *exceeded* the Standard 62.1-2007 calculated ventilation requirements. Therefore, all three tenant spaces being served by ERV-402 are Standard 62.1-2007 compliant.

In fact, the original outside air calculated was 65% higher than the found minimum outside air required. It's important to remember that the original designer was very conservative with his calculations for the future tenant spaces. Without knowing the future occupancy type or population, it was necessary to estimate the amount of outside on the high side, to ensure the original system would be able to handle the new tenants without needing to be replaced.

Standard 90.1 – 2007 Evaluation

According to ASHRAE Standard 90.1, its purpose is to "provide minimum requirements for the energy-efficient design of buildings except low-rise residential buildings". Within the scope of the standard includes new systems and equipment in existing buildings, in which the Hershey Press Building would be considered.

Section 5 – Building Envelope

The Hershey Press Building, located in Hershey, Pennsylvania, is included in the Climate Zone 5A, according Appendix B in the standard.

According to the *Compliance Paths,* Section 5.2.1, the building can be evaluated using the Prescriptive Building Envelope Option since "the vertical fenestration area does not exceed 50% of the gross wall area for each space-conditioning category. With over 200 windows, the 40% of glass area for the entire building is not surprising. See Table 1-3 for the calculation used to determine the total glass percentages.

Hershey Press Building Roof & Building Envelope Wall/Glass Values			
	SF	Glazing	% Glazing
Roof	24,710	0	0%
Walls	36,900	14675	39.8%

Table 1-3: Hershey Press Building Roof & Building Envelope Glazing Percentages

Back during the original construction, a brick encased concrete block facade supported by a concrete structural system, a relatively insulated R-value was established. The roof, walls, floors, and glass can be checked for meeting their energy-efficiency. By calculating the U-values, for the different building envelope elements, it can be checked for meeting 90.1 Building Envelope Requirements in Table 5.5-5.

For the roof, the construction is a 6" Concrete slab roof with 2" ISO insulation and EPDM Single-Ply membrane. The overall roof construction U-value is 0.12 (R-value of 8). The standard requires roof insulation entirely above deck for a non-residential roof to have a maximum assembly U-value of 0.63 (Insulation minimum of R-15). Therefore, the roof of the Press Building meets the Roof Building Envelope Requirements.

For the walls, a U-value of 0.13 (R-Value = 7.86) was found for the Hershey Press Building. See Table 1-4 for the derivation of these values. Since the walls are Nonresidential, mass walls, above grade, the maximum u-value is 0.123 (Minimum R-Value = 7.6). Therefore, the walls of the Hershey Press Building do not meet the Wall Building Envelope Requirements.

Hershey Press Building Thermal Wall Properties	
Layer	R-Value
Inside Air Film	0.68
5/8" Gypsum Board	0.56
1" Insulation	3.33
12" HW Concrete Block (filled)	2.56
4" Face Brick	0.56
Outside Surface Resistance	0.17
Total R-Value	7.86
Total U-Value	0.13

Table 1-4: Hershey Press Building Thermal Wall U & R Value Properties

For the floor, a 6" concrete slab on grade is used. Its overall U-value is 0.53. According to Table5.5-1, the maximum assembly U-value for an unheated, slab on grade floor is 0.73. According to this value, the Press Building's floor meets the Floor Building Envelope Requirements.

For fenestration elements, the Press Building has double coated ¼" glass picture windows, non operable. The U-value for the windows is 0.29 with a shading coefficient of 0.43. For the standard, it requires fenestration with 30.1-40% vertical glazing of wall for fixed windows to be 0.57 U-value and 0.49 shading coefficient. Therefore, the Press Building windows do meet the window standards for 90.1 due to the high shading coefficient.

See Table 1-5 for a summary of the building envelope requirement compliancy.

Hershey Press Building Building Envelope Requirements Summary			
Opaque/Fenestration Elements	Max. U Value Req'd	Actual U-value	Meets Standard?
Roof - Insulation Entirely Above Deck	0.63	0.12	Yes
Walls - Above Grade, Mass	0.12	0.13	No
Floors – Slab on Grade, Unheated	0.73	0.53	Yes
Windows - Vertical Glazing of 30.1-40% of Wall, fixed	0.57 w/maximum SHGC of 0.39	0.29 w/ SHGC of 0.43	No

Table 1-5: Hershey Press Building – Building Envelope Requirements for Zone 5 Summary

Section 6 – Heating, Ventilating, and Air Conditioning

In order to meet Section 6.4 *Mandatory Provisions* and Section 6.5 *Prescriptive Paths*, the building must have more than 2 stories and the overall square feet must be greater than 25,000. Since the Press Building has 3-story, 75,000 square foot building, it is included in both these sections.

For starters, the water-source heat pumps must follow the efficiency standards of Table 6.8.1D – *Packaged Terminal and Room Air Conditioners and Heat Pumps.* The minimum efficiency for a replacement packaged terminal heat pumps (PTHP) in cooling is 10.8 EER and for heating is 2.9 EER. The heat pumps installed in the building have a cooling EER of 14.2-14.6 and a heating COP of 4.5-4.6. The installed heat pumps meet the standard.

The boiler, found in Table 6.8.1F of the standard, requires that all Gas-Fired Boilers, greater than 300 MBH, at maximum capacity should have a minimum efficiency of 75%. The three installed boilers meet the standard, each of which has an efficiency of 80%.

In the same regard, the closed loop fluid cooler is considered a type of heat rejection equipment, and Table 6.8.1G of the standard handles the efficiency requirements. Similar to a propeller or axial fan cooling tower, the fluid cooler is required to meet a performance level greater than 20 gallons per minute (gpm) per horse power (hp). The press building's heat pump is 690 gpm and has two 15 hp motors. Therefore, it has a ratio of 23 gpm/hp, thus it does not meet the standard.

The exhaust hoods, vents and ventilators are all equipped with motorized dampers, thus meeting standard 6.4.3.3.2. The maximum leakage for the damper is less than 10 CFM/square foot of damper area.

All ducts that are located in non-conditioned spaces, not including plenums, need to be insulated according to Section 6.4.4.1. The ducts for the press building are insulated in the shafts and on the roof, therefore following the standard's requirements. Also, all the pipe that is located in critical conditions where condensate is not welcome, needs to be insulated.

Since heat pumps are being utilized, each heat pump will have its own zone controls for re-heating, re-cooling, and/or mixing with conditioned room air. Therefore, the system meets section 6.5.2.1 of the standard. In section 6.5.4.4, the standard asks that each hydronic pump should have a two-position automatic valve interlocked to shut of water flow when the compressor is off. After reviewing the specifications for the heat pumps, it indeed is in line with this standard.

Hydronic (Water Loop) Heat Pump Systems, discussed in section 6.5.2.2.3, requires that the loop have controls that are capable of a 20°F deadband for the supply water temperature, which the Press Building is able to do. Following the code for fluid coolers, the Press Building also has an automatic valve to bypass all but minimal flow pass the cooler.

The ERV-402 is a 7.5 hp for a maximum 9,600 CFM outside area/supply air volume. In other words, it can serve a constant volume of 0.78 hp/1000 CFM. The standard, as stated in Table 6.5.3.1, demands that the fan power shall not exceed 1.2hp/1000 CFM for a constant volume supply air volume less than 20,000 CFM. Therefore, the energy recovery ventilator meets this criterion.

In Section 6.5.6 of the standard, there are specifications that deal specifically with *Energy Recovery*. The system is a perfect candidate for heat recovery since the capacity of the ERV is greater than 5000 CFM (9600 CFM) and has a minimum outside air supply of 70% or greater (100%). Therefore, the silica gel energy wheel is following the 50% energy recovery effectiveness from the recovery of energy from the exhaust/relief air of the system.

The following section, Section 6.5.7, goes into the specification for kitchen hoods. Since the two individual kitchen hoods for Devon Seafood and Houlihan's Restaurant are both larger than 5,000 CFM, the standard requires that the makeup air unit should be sized for at least 60% of the exhaust air volume. The make-up air units for Houlihan's and Devon Seafood are sized for 85% and 94% of the kitchen hood exhausts respectively, thus following the standard.

Section 7 – Service Water Heating

The Hershey Press Building has four domestic hot water heaters to serve the building. Located in the basement, three gas-fired boilers, and one auxiliary boiler, supply heated water to the heat pump loops. All boilers have a 94% thermal efficiency and each having an input varying from 500-540 MBH.

The standard, in Table 7.8, requires the performance of gas storage water heaters, greater than 75 MBG, to have a minimum thermal efficiency of 90%. All of the domestic water heaters meet this standard.

Section 8 – Power

In terms of voltage drop, all feeders shall be sized for a maximum voltage drop of 2% at design load. Also, branch circuits shall be sized for a maximum voltage drop of 3% at design load.

Section 9 – Lighting

In this section, 90.1 discusses the requirements for lighting systems in buildings. Because the Hershey Press Building has a mixed occupancy, it is necessary to take the most conservative value and apply that to the entire building. For example, according to Table 9.5.1, the maximum lighting power density for a dining-bar lounge/leisure area is 1.3 watts per square foot and for an office building is 1.0 watts per square foot. By using the Building Area Method, I summed the watts per square foot for the entire facility as well as the area. The results were astounding. As seen in Appendix C – Lighting Desnsity Calculations, on page 22, the building's overall power density is 1.9 watts per square foot, which is extremely high and does not pass code.

The reason the building's lighting power density is so high is due to old fixtures and aesthetically-pleasing lighting plans. The architect was concerned only for the "look" of the lighting, and less concerned with energy conservation. One way to reduce the power density is to determine space by space criteria for lighting density and reduce each space accordingly.

Section 10 – Other Equipment

After comparing Table 10.8 *Minimum Nominal Efficiency for General Purpose Design A and Design B Motors*, it became apparent, after comparing the date to the Press Building's data, that all motors met the criterion.

Section 11 – Energy Cost Budget Method

This section deals with modeling a building to see if it meet the energy cost budget. I will go in more detail of this requirement in the Technical II assignment.

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.

Appendices

Appendix A – Original O/A Calculations

Houlihan's Original O/A Calculations Based On International Mechanical Code 2003, Sect. 403.3					
Room Type	CFM_{OA}/SF	CFM_{OA}/Person	AREA (SF)	People	Total CFM
Food Service Dining	-	20	-	140	2,800
Bar Dining	-	30	-	72	2,160
Restaurant Staff	-	20	-	40	800
Total					5,760

Lobby Original O/A Calculations Based On International Mechanical Code 2003, Sect. 403.3					
Room Type	CFM_{OA}/SF	CFM_{OA}/Person	AREA (SF)	People	Total CFM
Lobby	0.05	-	500	-	25
Total					25

Jack Gaughen Realty Original O/A Calculations Based On International Mechanical Code 2003, Sect. 403.3					
Room Type	CFM_{OA}/SF	CFM_{OA}/Person	AREA (SF)	People	Total CFM
Corridors	0.05	-	1,092	-	55
Storage Rooms	0.15	-	100	-	15
Conference Rooms	-	20	-	20	400
Office Spaces	-	20	-	60	1,200
Reception Spaces	-	15	-	17	255
Total					1,925

Devon Seafood Grille Original O/A Calculations Based On ASHRAE Standard 62.1 - 2004					
Room Type	Ra (CFM/SF)	Rp (CFM/P)	AREA (SF)	People	Total CFM
Main Dining	0.18	7.5	1,974	111	1,188
Private Room	0.18	7.5	353	15	176
Banquet Room	0.18	7.5	527	32	335
Bar Dining	0.18	7.5	1,830	66	824
Bar	0.18	7.5	964	17	301
Office	0.06	5	112	2	17
Kitchen A	0.18	7.5	856	3	177
Kitchen B	0.18	7.5	1,193	3	237
Storage	0.06	0	725	1	44
Total					3,298

Appendix B – Required O/A Calculations

Hershey Press Building ERV-402 ASHRAE Standard 62.1-2007 Calculations															
Zone Chacteristics								ASHRAE STANDARD 62.1 - 2007							
Zone Number	Zone Name	Tenant	Occupancy Catergory	Served By	Area (SF)	Pz (people)	Vdzd (cfm)	Raz (cfm/sf)	Rpz (cfm/p)	Vbz (cfm)	Ez	Voz (cfm)	Zp	Evz
1	Lobby	All	Lobbies	HP-101	400	0	400	0.06	5	24	1.0	24	0.06	1.12
2	Server Room	Jack Gauhen	Storage Rooms	HP-102	100	0	400	0.12	0	12	1.0	12	0.03	1.15
3	Circulation Space	Jack Gauhen	Lobbies	HP-103 HP-105 HP-119	1157	9	1,200	0.06	5	114	1.0	114	0.10	1.08
4	Conference	Jack Gauhen	Conference/Meeting	HP-104 HP-114	480	20	1,400	0.06	5	129	1.0	129	0.09	1.08
5	Offices	Jack Gauhen	Office Space	HP-106 HP-115 HP-118	1007	12	1,800	0.06	5	120	1.0	120	0.07	1.11
6	Open Offices	Jack Gauhen	Office Space	HP-107 HP-116 HP-117	2435	46	3,400	0.06	5	376	1.0	376	0.11	1.06
7	Corridor	Houlihan's	Corridors	HP-130A	240	0	150	0.06	0	14	1.0	14	0.10	1.08
8	Private Dining Room	Houlihan's	Restaurant Dining Rooms	HP-130B	382	16	700	0.18	7.5	189	1.0	189	0.27	0.91
9	Kitchen	Houlihan's	Restaurant Dining Rooms	HP-109A	1861	14	5,750	0.18	7.5	440	1.0	440	0.08	1.10
10	Office	Houlihan's	Office Space	HP-109B	71	1	250	0.06	5	9	1.0	9	0.04	1.14
11	Dining Room	Houlihan's	Restaurant Dining Rooms	HP-110 HP-111 HP-112	4482	202	8,800	0.18	7.5	2322	1.0	2322	0.26	0.91
12	Dining Room	Devon Seafood	Restaurant Dining Rooms	HP-120 HP-123 HP-124	4768	194	7,000	0.18	7.5	2313	1.0	2313	0.33	0.84
13	Private Dining Room	Devon Seafood	Restaurant Dining Rooms	HP-121	353	15	850	0.18	7.5	176	1.0	176	0.21	0.97
14	Banquet Dining Room	Devon Seafood	Restaurant Dining Rooms	HP-122	527	32	1,200	0.18	7.5	335	1.0	335	0.28	0.90
15	Office	Devon Seafood	Office Space	HP-125	112	2	500	0.06	5	17	1.0	17	0.03	1.14
16	Kitchen	Devon Seafood	Restaurant Dining Rooms	HP-126 HP-127	2062	6	5,600	0.18	7.5	416	1.0	416	0.07	1.10
17	Coolers	Devon Seafood	Storage Rooms	HP-128 HP-129	30	0	600	0.12	0	4	1.0	4	0.01	1.17

Appendix C – Lighting Density Calculations

Hershey Press Building Lighting Density Calculations						
Room Number	Room Type	Lamps	Type of Lamp	Watts	Area	Watts/SF
1	Storage	1	ST8	128	177	0.72
2	Storage	1	ST8	128	294	0.65
		1	ST4	64		
3	Vestibule	2	DL1	104	68	1.53
4	Lobby	6	DL1	312	291	1.07
5	Storage	1	ST4	64	356	0.54
		1	ST8	128		
6	Storage	2	ST8	256	288	0.89
7	Storage	8	ST8	1024	922	1.11
8	Storage	2	ST8	256	360	0.71
9	Boiler Room	4	ST8	512	423	1.21
10	Corridor	10	ST8	1280	2184	0.62
		1	ST4	64		
11	Main Elect. Rm	4	ST8	512	391	1.31
12	Storage	8	ST8	1024	998	1.03
13	Storage	1	ST8	128	245	0.52
14	Storage	2	ST8	256	300	0.85
15	Corridor	10	DL1	520	417	1.25
16	Elevator Mech Rm	1	ST4	64	158	1.22
		1	ST8	128		
17	Storage	1	ST8	128	199	0.64
18	Storage	14	ST8	1792	2294	0.78
19	Main Tele	2	ST8	256	290	0.88
S03	Stair #3	2	S2	128	117	1.09
S04	Stair #4	1	ST8	128	206	0.62

100	Entry/Waiting	22		1550	343	4.52
101	Vestibule	6		450	52	8.65
102	Reception	11		1075	238	4.52
103	Dining Room	19		950	303	3.14
104	Vestibule	1		50	98	0.51
105	Bar Dining	22		2688	1325	2.03
106	Dining Room 1	22		1790	986	1.82
107	Corridor	7		725	467	1.55
108	Dining Room 2			900	648	1.39
109	Private Dining			675	137	4.93
110	Liquor Storage			64	53	1.21

1112	Expo Line			600	252	2.38
113	Cook Line			612	279	2.19
114	Prep			640	355	1.80
115	Cooler			192	281	0.68
116	Trash Cooler			64	75	0.85
117	Dry Storage			192	200	0.96
118	Empolyee Toilet			64	53	1.21
119	Dishwashing			448	230	1.95
120	Office			64	70	0.91
121	Men			350	121	2.89
122	Janitor's			64	41	1.56
123	Women			400	136	2.94

201	Elevator/Lobby	7	DPL	1400	1210	1.16
202	Entry Hall	8	DL1	416	100	4.16
202A	IDF	2	L2	128	100	1.28
203	NW Corridor	11	LP2	1056	890	1.19
204	Open Office	2	P24	100	500	0.20
205	Admin Area	1	P12/C16	50	145	0.34
206	Electrical Rm	2	ST4	128	50	2.56
207	HR Office	1	P12	50	180	0.28
208	HR Office	1	P12	50	150	0.33
209	HR Office	1	P12	50	150	0.33
210	HR Office	1	P12	50	180	0.28
211	HR Office	1	P12	50	150	0.33
212	HR Office	2	P12	100	250	0.40
213	Copy Room	2	L1	256	180	1.42
214	HR Office	1	P8/4	50	100	0.50
215	File Room	1	L1	128	180	0.71
216	HR Office	1	P8/C16	1260	164	7.68
217	HR Office	1	P8/C16	1260	164	7.68
218	HR Fullfillment	1	P8/C16	1260	164	7.68
219	Mail Room	2	L1	256	314	0.82
220	North Corridor	8	DL1	416	530	0.78
220A	Vestibule	5	LP2	480	400	1.20
221	Open Office	1	P56	50	2535	2.32
		1	P56E	1260		
		1	P48	1152		
		1	P48E	1152		
		2	P44	2112		
		3	WWDL	156		
222	CR Office	1	P12	50	150	0.33
223	CR Office	1	P12	50	150	0.33
224	Break Room	2	L1	256	180	1.42
225	CR Office	1	P12	50	180	0.28
226	Storage	1	L2	64	50	1.28

227	Toilet	1	L2	64	50	1.28
228	Toilet	1	L2	64	50	1.28
229	Coats	1	DL1	52	45	1.16
230	Coats	1	DL1	52	45	1.16
231	Copy Room	1	L1	128	100	1.28
232	NE Corridor	14	LP2	1344	1200	1.12
233	Future Office	2	L2	128	180	0.71
234	Future Office	1	P12	50	180	0.28
235	Confrence	1	P12	50	200	0.25
236	Confrence	1	P12	50	225	0.22
237	Lunchroom	1	P24	576	1100	1.33
		1	P24E	576		
		4	DL1	208		
		2	WWDL	104		
238	Women's Toilet	3	L2	192	400	0.61
		1	DL1	52		
239	Men's Toilet	3	L2	192	400	0.61
		1	DL1	52		
239A	Office	2	R1	180	300	0.85
		1	R2	75		
240	Open Office	1	P40	960	1100	2.86
		1	P48	1152		
		7	LP2	672		
		7	DL1	364		
241	Open Office	4	D28	384	1520	0.25
242	SW Corridor	9	LP2	864	285	3.03
242a	File Corridor	4	COVE	256	120	2.13
243	Admin Area	2	P8	2520	1200	2.10
244	Confrence	2	P12/S/C16	576	350	1.65
245	Mail File Rm	1	L1	128	50	2.56
246	Storage	2	L1	256	200	1.28
247	Office	1	P12	50	180	0.28
249	PM Office	1	P8	1260	150	8.40
250	PM Office	1	P8	1260	150	8.40
251	PM Office	1	P8	1260	150	8.40
252	PM Office	1	P8	1260	150	8.40
253	PM Office	1	P12	50	160	0.31
254	MA Office	2	P12/S	100	288	0.35
255	PM Office	1	P12	50	168	0.30
256	CMCS Office	1	P12	50	156	0.32
257	CMCS Office	2	P12/S	100	234	0.43
258	CMCS Office	1	P12	50	150	0.33
260	Copy	1	L1	128	100	1.28
261	Vestibule	1	LP2	96	135	0.71
262	Vestibule	1	LP2	96	50	1.92
263	CMCS Office	1	P8	1260	150	8.40

264	CMCS Office	1	P8	1260	150	8.40
265	CMCS Office	1	P8	1260	150	8.40
S2	Stair #2	2	S2	128	100	1.28
S3	Stair #3	2	S2	128	100	1.28
S4	Stair #4	2	S2	128	100	1.28

301	Reception	5	DPL	1000	745	1.34
301A	Corridor	3	DL1	156	100	1.56
302	NW Corridor	10	RP	750	1200	
		1	XL	75		
303	Elec Room	2	ST4	128	50	2.56
304	Confernce	2	P8	100	250	0.40
305	Confernce	2	P8	384	250	1.54
306	Confernce	2	P8	384	250	1.54
307	Dining	10	R2	750	740	2.23
		3	DPC	300		
		6	WW4	600		
308	Vesibule	2	Track 1	150	100	5.50
		2	DPL	400		
308A	Vesibule	1	LP2	96	50	1.92
309	Coats	1	LP2	96	40	2.40
310	Legal Office	1	P8	50	100	0.50
311	Legal Office	1	P12	50	180	0.28
312	Admin	2	P8	100	150	0.67
313	Legal Office	2	P8	100	250	1.48
		3	WW6	270		
314	Legal Office	2	P8	100	225	0.44
315	CEO Confernce	2	WW6	180	250	3.32
		5	WW6	450		
		2	DPC	200		
316	Corridor	39	WW5	1950	670	3.52
		4	WWDL	208		
318	Toilet	1	R2	75	100	1.50
		1	W1	75		
319	CEO Office	2	WW6	180	325	0.55
		6	R1	540		
320	Admin	2	P8	384	230	1.67
321	Visitor Office	2	P8	384	230	1.67
322	Acct Office	2	P12	100	250	0.40
323	Conrence Rm	2	DPC	200	325	2.28
		6	WWD2	540		
324	Corridor	2	DL1	104	620	0.17
325	Boardroom	10	S3	640	800	4.55
		30	T75	2250		
		5	R1	450		
		4	Track 2	300		

326	Kitchen	2	L1	256	230	1.11
327	Exec Copy	1	L1	128	95	1.35
328	Storage	1	L1	128	95	1.35
329	Service Corridor	7	LP2	672	120	5.60
330	Toilet	1	L2	64	100	0.64
331	Toilet	1	L2	64	100	0.64
332	Storage	1	L2	64	95	0.67
333	NE Corridor	2	P24	1152	1250	0.92
334	Legal Storage	1	L1	128	250	0.51
335	Copy	2	L1	256	100	2.56
336	Admin	1	P12	50	100	0.50
337	Acct Office	1	P8/4	1260	100	12.60
338	Acct Office	1	P8/4	1260	100	12.60
339	DF	2	L2	128	100	1.28
340	Acct Office	1	P8/4	1260	100	12.60
341	Coffee Room	2	L1	256	200	1.28
342	Acct Office	1	P12	50	180	0.28
343	Acct Office	1	P12	50	180	0.28
344	Acct Office	1	P12	50	180	0.28
345	Acct Office	2	L1	256	300	0.85
346	Open Office Space	1	P96	2304	1580	3.07
		1	P96E	2304		
		1	P12	50		
		2	LP1	192		
347	Corridor	4	DL1	208	165	1.26
347A	Janitor's Closet	1	L2	64	95	0.67
348	SW Corridor	9	LP2	864	330	2.62
348A	Vestibule	1	LP2	96	95	1.01
348B	Vestibule	1	C2	32	95	0.34
349	Confernce	2	P8	2520	250	10.08
350	Acct Office	1	P12	50	150	0.33
351	Acct Office	1	P12	50	150	0.33
352	Future Office	1	P12	50	150	0.33
353	Future Office	1	P12	50	150	0.33
354	IT Office	1	P12	50	150	0.33
355	IT Office	1	P12	50	150	0.33
356	IT Office	1	P12	50	150	0.33
357	Team Room	1	P12	50	250	5.24
		1	P8	1260		
358	IT Office	1	P12	50	180	0.28
359	IT Office	1	P12	50	150	0.33
360	Future Office	1	P12	50	180	0.28
361	Future Office	1	P12	50	260	5.04
		1	P8	1260		
362	IT	1	P12	50	150	0.33
363	Coffee Room	3	P12	150	95	1.58

364	Fitness	3	L1	384	475	0.81
366	Training	4	P12	200	500	0.40
367	Computer Room	4	L1	512	480	1.07
368	Storage	2	L2	128	140	0.91
369	Lab/Setup	1	P16	50	210	0.24
370	Men's Toilet	3	L2	192	100	2.44
		1	DL1	52		
371	Men's Showers	3	L2	192	175	2.14
		2	SH	150		
		1	C2	32		
372	Women's Showers	3	L2	192	175	2.14
		2	SH	150		
		1	C2	32		
373	Women's Toilet	3	C2	32	100	0.84
		1	DL1	52		
S2	Stair #2	2	S2	128	100	1.28
S3	Stair #3	2	S2	128	100	1.28
S4	Stair #4	1	S2	64	100	0.64

Total	99037	59523	1.92