PROJECT BACKGROUND

5.1. Design Objectives and Requirements

The Mount St. Mary's University began this new student housing project with a budget of approximately $10 Million, and their goal was to create a sustainable, environmentally friendly dormitory to house their growing population of students.

The vision for the project was to create an inviting dormitory consisting of 3- and 4-bedroom suites, each with their own living area and bathroom, as well as ample lounge space in which students could congregate and study. Each of these living units would have complete control over thermal comfort and lighting, and mechanical equipment would be as inconspicuous as possible. The building itself was to resemble a rural village, complementing the rest of the campus without being overly obtrusive, and at the same time, it had to be large enough to house approximately 200 students comfortably.

The university was also very interested in sustainable or "green" technologies. They wanted to project an image of environmental consciousness without taxing their budget too sorely or compromising the function of the building. A large number of windows were desired to take advantage of natural ventilation, and the university wanted to look into different options of sustainable design, such as energy recovery and geothermal heating and cooling, both of which were eventually adopted.

5.2. LEED Green Design Analysis

Created by the U.S. Green Building Council (USGBC), the Leadership in Energy and Environmental Design (LEED) rating system is considered to be the "nationally accepted benchmark for the design, construction, and operation of high performance green buildings." Utilization of the LEED system encourages an environmentally friendly approach to building design, while at the same time saving on building operating costs.

Four levels of LEED certification exist and are dependant upon the number of credits a building receives under six different categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, and Innovation and Design Process. Receiving between 26 and 32 credits allows a building to become Certified, 33 to 38 receive a Silver rating, 39 to 51 will receive Gold, and 52 to 69 receive Platinum.

Those involved with the new student housing project at the Mount St. Mary's University were very interested in creating an efficient building that would also demonstrate the university's commitment to environmentally conscious design practices. Because this housing project was entirely new construction, a preliminary study of compliance to LEED-NC Version 2.2 was undertaken. Although the university has chosen not to pursue a LEED classification, the building would, in fact, have received a minimum of 26 credits and been a candidate for basic certification. It could possibly have been designed to receive a Silver rating if the university had pushed for certain credits, such as Innovative Wastewater Technologies, Measurement and Verification, Outdoor Air Delivery Monitoring, and Controllability of Systems.

Credits that would have been achieved due to mechanical systems are largely from three of the six categories: Water Efficiency, Energy and Atmosphere, and Indoor Environmental Quality. Requirements for Water Use Reduction, Enhanced Refrigerant Management, and Thermal Comfort credits were all designed into the building mechanical systems, and of the ten possible Optimize Energy Performance credits, it was assumed that a minimum of three could have been attained by the geothermal heat pump system. The entire LEED-NC checklist as it was compiled in the initial preliminary analysis is available in Appendix A of this report.

5.3. Site Factors Influencing Design

One of the objectives of the new student housing project was for the final design of the building to fit in with the style of the campus and project the image of a rural village. The desired gabled roof allowed little space for a cooling tower or the condensing units that are required in air source applications. The university also disliked the idea of a "farm" of condensing units clustered directly behind the building. The rural atmosphere of the campus forced the university to look into other, less obvious approaches, and when the geothermal system was suggested, they happily accepted this alternative. Geothermal wells are invisible to the general public, and the system's efficient ability to save on energy usage made it even more attractive.

Also, the extremes of the temperature ranges in the summer and winter months allowed energy recovery to be adopted by the university for the project. Prior to the addition of the energy recovery units, the building design had been relying entirely on natural ventilation to meet the building's outdoor air requirements. As another form of sustainable design, these units could replace the exhaust fans with only a short period of payback while allowing a more generous amount of ventilation air to be introduced into the building.

5.4. Indoor and Outdoor Design Conditions

The indoor design conditions on this project were based on standard summer and winter comfort levels for residential buildings. While each suite will have its own thermostat, allowing students to regulate the temperature to their own levels of comfort, the building was designed to maintain the setpoints that are listed in Table 5.4.1 below:

Table 5.4.1: Indoor Design Conditions

DESIGN CONDITIONS SCHEDULE										
Room Description	Occupied Hours						Unoccupied Hours			
	Summer		Winter		Ventilation		Summer		Winter	
	DB (°F)	% RH	DB (°F)	% RH	OA CFM	AC/hr	DB (°F)	% RH	DB (°F)	% RH
Residential Suite	75	50	70	30	50	1.0	85	50	65	30
Lobby	75	50	70	30	50	0.8	85	50	65	30
Lounge	75	50	70	30	50	0.8	85	50	65	30
Small Lounge	75	50	70	30	50	1.0	85	50	65	30
Electrical Room / Hallway	75	50	70	30	50	1.8	85	50	65	30

Outdoor design conditions were taken from Carrier's HAP for the city of Hagerstown, Maryland. They are shown in Table 5.4.2 below:

Table 5.4.2: Outdoor Design Conditions

OUTDOOR DESIGN CONDITIONS				
Design:				
	Dry Bulb Temp (°F)		Wet Bulb Temp (°F)	
Summer	94.0		75.0	
Winter	8.0		5.8	
Monthly:				
	Max. DBT	Min. DBT	Max. WBT	Min. WBT
January	50.8	28.8	47.0	28.3
February	54.0	32.0	52.0	31.5
March	65.0	43.0	61.0	42.5
April	75.0	53.0	65.0	52.5
May	84.8	62.8	70.0	62.3
June	91.0	69.0	73.0	66.5
July	94.0	72.0	75.0	68.8
August	94.0	72.0	75.0	68.8
September	88.8	66.8	72.0	65.4
October	78.0	56.0	67.0	55.5
November	68.8	46.8	61.0	46.3
December	56.0	34.0	52.0	33.5

5.5. Energy Sources and Rates

The new student housing project at the Mount St. Mary's University uses electricity for most of its systems, making use of natural gas only for the domestic hot water heater. Because the new student housing project is not yet built, electric and natural gas rates were assumed comparable to those provided by Baltimore Gas and Electric.

Electric rates were taken from the Large General Service schedule for Type II-A Market priced service. The electric service rates were separated into delivery service customer charge, demand charges, energy charges, and a delivery service charge. The energy charges were divided into peak, intermediate, and off-peak periods. Information pertaining to rating periods and electrical utility rates may be found in respective Tables B.1 and B.2 of Appendix B of this report.

Natural gas rates were taken from the General Service-C schedule, and rates were separated into customer and delivery charges. The distribution charge was broken down based on the amount of gas (therms) used in one month. Information pertaining to natural gas rates may be found in Table B.3 of Appendix B of this report.

There are no known incentives being offered that would influence energy consumption or operational costs.

5.6. Design Ventilation Requirements

The new student housing project at the Mount St. Mary's University utilizes a dedicated outdoor air system with energy recovery coupled with natural ventilation. Three energy recovery units provide a constant flow of 50 CFM of outdoor air to each of the building's heat pumps. It was determined by previous analysis that natural ventilation from the windows alone would have been sufficient to adequately ventilate the building to the approval of Standard 62.1-2004.

It was determined by the mechanical consultant on the project that should natural ventilation alone be used, the building would be very negatively pressurized as well as possibly being underventilated in the winter months when windows would most often be closed. The energy recovery units were, therefore, proposed as an alternative to simple exhaust fans. Due to the University's dedication to environmentally friendly design, they adopted the plan, which would have initially supplied 100 CFM of ventilation air to each of the heat pumps. The flow was cut back to 50 CFM due to cost restraints.

A building ventilation analysis was performed on the building's mechanical ventilation systems based on ASHRAE Standard 62.1-2004. The results of that study may be seen in Table 5.6.1 below:

Table 5.6.1: Calculated vs. Design Ventilation Flow Rates

	Max Z_p	System Ventilation Efficiency (E_v)	Population Density (P_s)	Occupant Diversity (D)	Uncorrected Outdoor Intake (V_{ou}) [CFM]	Nominal Outside Air (ΣV_{oz}) [CFM]	Required Outside Air (V_{ot}) [CFM]	Actual Supplied Ventilation Air [CFM]
ERU-1	0.11	1	60	0.87	1102	1161	1102	1050
ERU-2	0.10	1	66	0.79	1325	1431	1325	1050
ERU-3	0.09	1	57	1.00	990	1001	990	750
Total Building						**3593**	**3417**	**2850**

At first glance, it would appear that all three ERU's are undersized and do not meet the building's ventilation requirements. However, one must keep in mind the fact that natural ventilation alone would be sufficient under the circumstances; the mechanical ventilation is only for supplemental and pressurization purposes. Had cost not constrained the units from delivering 100 CFM to each of the pumps, the mechanical system alone would have far exceeded the requirements listed in the Standard.

5.7. Design Heating and Cooling Loads

In order to create a comparison of estimated heating and cooling loads to those scheduled by the mechanical engineer, Carrier HAP was utilized to simulate the new student housing project at the Mount St. Mary's University. A brief summary of calculated load results as compared to actual design data is provided in Table 5.7.1 below. Some inconsistencies between the numbers can be contributed to incorrect estimates of schedules, lighting and electrical equipment power densities, and other general conditions. The large difference in the cooling and heating loads may also be contributed to the fact that the design data is based on the total rated capacity of the building's various geothermal heat pumps; the actual loads being seen by these units are not described on the design documents and are probably less than their rated capacities.

Table 5.7.1: Calculated vs. Design Cooling and Heating Loads

Energy Usage Comparisons						
System	Output	Cooling Total (Tons)	Cooling Sensible (Tons)	Heating (Tons)	Cooling (ft^2/Ton)	Heating (ft^2/Ton)
ERU-1	HAP	23.0	20.2	22.0	634	664
	Design	36.9	30.8	33.9	395	430
ERU-2	HAP	28.5	24.5	27.1	619	649
	Design	41.4	33.1	36.3	426	484
ERU-3	HAP	19.6	17.0	19.8	662	655
	Design	31.3	23.6	25.6	414	505