Thesis Proposal for Berks Classroom and Lab Building

Berks Classroom and Lab Building - Berks Campus Reading, PA

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1. Executive Summary

This proposal is to outline work for Spring 2012 semester in compliance with the A E department's thesis requirements. Outlined below is the depth work, tools for analysis, and the two breadth topics.

The mechanical depth work will include the design of a ground source heat pump and its impact on the sizes of the RTU's.

The tools used for this analysis will included Trane Trace, or equivalent program, RS Means, a scheduling software and for the electrical redesign NEC 2009.

There are two breadth topics to be considered as well. The two breadth topics are a construction management breadth and an electrical breadth. The construction management breadth will included a cost analysis of all work redesigned and the impact on the schedule for construction. These numbers will be reported as just the cost for the redesign and not the full building and the schedule will be represented as the amount of days difference. The electrical breadth will consist of designing the electrical component for the proposed mechanical redesign and a redesign of equipment affected by the redesign.

Included with this proposal is a work plan devised to anticipate work complete throughout the semester. This includes milestones for both breadths and the mechanical depth work. This proposal and work plan are subject to revision upon return to classes in January.

2. Introduction

Berks Classroom and Lab Building is located on Penn State's Berks Campus, located near Reading, Pennsylvania in Berks County. Penn State Berks sits among rolling hill and tree-lined pathways. The campus has a rich history, considering it was not always part of the Penn State system. The campus started as Wyomissing Polytechnic Institute (WPI) and became part of the Penn State System in 1958. In 1972 it moved to the Spring Township location and added residence halls in 1990. Even though there is rich history with the campus Penn State did not have to follow any historical requirements.

Berks Classroom and Lab Building is 62,188 square feet with all three levels above ground the occupancy for the building is designated as Group B – Business. The building was started in April 2010 and is scheduled to be completed in either August or September of 2011. The delivery method was design-bid-build. As with the new buildings at Penn State, Berks Classroom and Lab Building is designed using LEED certification and after completion is anticipated to achieve a LEED Silver rating under LEED 2.2.

The design team is as follows:

Owner: The Pennsylvania State University Berks Campus

General Contractor: Alvin H Butz, Inc.

Construction Cost Estimator: Becker & Frondorf

Building Architect: RMJM Hiller

Engineers:

Structural: Greenman-Pedersen, Inc.

MEP: H.F. Lenz Company

Civil: Gannett Fleming Engineers

Lighting Consultant: Illumination Arts, LLC

Acoustical Consultant: Shen Milsom Wilke, Inc.

They used multiple codes in the design of Berks Classroom and Lab Building; the codes are mostly 2006 with one exception being 2003. The code are as follows: International Building Code, International Mechanical Code, International Plumbing Code, International Energy Conservation Code, International Code Council Electrical Code, International Fire Code, and Accessibility Code ICC/ANSI 117.1 2003. There were some zoning requirements which included a Land Development Permit (LDP) from Springs Township and an NPDES permit was required from Berks County Conservation District (BCCD).

The building façade of the first floor is consists of two different types of façade, the first and closest to grade are Architectural precast concrete panels backed with an airspace rigid insulation air space and finally a masonry wall. The second part of the first floor façade has an aluminum curtain wall system in place of the architectural precast concrete panels, the two airspaces and rigid insulation. Above the first floor the façade changes again to have an exterior finish of terracotta rain screen backed by rigid insulation backed by cold formed metal framing (CMFM).

The roof system consists of metal decking covered by rigid composite insulation and a Kee membrane. KEE stands for ketone ethylene ester and is gaining popularity in Southern California because of its great waterproofing protection and lightweight design. The KEE membrane is a single-ply, lightweight vinyl and is extremely easy to install. The install for most types of the KEE membrane requires the contractors to use a simple hot air bonding technique; this creates a seamless molecular bond between each sheet of the

membrane. This makes the membrane easy to repair and remains highly flexible with age, making it easy to uncover the substructure for repairs if needed.

Considering the Berks Classroom and Lab Building is designed to achieve a LEED Silver rating at completion. The building utilizes a gray water system; this system is designed to supply the restrooms within the building with water for their water closets and urinals. Other things considered for LEED rating was using materials that are made within a 500 mile radius from the site.

3. System Description

The building utilizes a VAV system that has an air side and hydronic side to it.

AIR SIDE:

On the air side there are three roof top air handling units (AHUs) that range from 26 tons to 70 tons.

HYDRONIC SIDE:

The water side consists of two gas fired boilers with a 6.2 gallon capacity and an output of 850 MBH. The building utilizes four Split system air conditioning units with rated capacities of either 1 or 1.5 tons. There are supplemental heaters located in two vestibules, two corridors and a stair well to help regulate the temperature of these spaces.

ZONE CONDITIONING:

The spaces are supplied air from Variable Air Volume Boxes (VAV Boxes). The server room is served by a computer room air conditioning unit (CRAC).

3.1. Design Objectives and Requirements

The objective of the HVAC system in the Berks Classroom and Lab Building are to properly ventilate the building and maintain comfortable temperatures and humidity levels for the occupancy and the surrounding temperatures. There are three roof top air handling units that serve 87 VAV boxes these roof top units are supplemented by 5 cabinet unit heaters and 3 horizontal unit heaters.

There are 2 main types of spaces in the building including office spaces and classroom spaces. Additional spaces include a café, kitchen, and conference spaces.

3.2. EQUIPMENT SUMMARY

The equipment for the Berks Classroom and Lab Building include three AHU's(RTU), eight additional heaters(UHT&CUH), a computer room air conditioning unit(CRAC), four split system air condition units(ACU), five hot water pumps(HWP) and two boilers(BLR). The roof top units are variable air volume systems and for this summary the VAV boxes will not be included but will be summarized with the AHUs. (RMJM Miller, 2009).

TABLE 1: ROOF TOP UNITS AND AC UNITS SUMMARY

Unit	System Supply (CFM)	% OA Min	Coil Capacities (MBH)	
			Heating	Cooling
RTU-1	20,500	16.6	414.8	799.6
RTU-2	14,000	39.4	366.8	471.4
RTU-3	10,725	29	324.4	318,4
ACU-1	-	-	-	12
ACU-2	-	-	-	18
ACU-3	-	-	-	18
ACU-4	-	-	-	18
CRAC-1	885/800	-	-	32.8

TABLE 2: HEATER SUMMARY

Unit	System Supply	Heating Capacity (MBH)
UHTM118	460	18.2
UHT109	460	18.2
UHTP110	460	18.2
CUHF105	430	24.9
CUHQ104	335	19.5
CUHF101	430	24.9
CUHZ101	630	40.5
CUHQ304	230	12.9

TABLE 3: SUMMARY OF BOILERS

Boiler	Input MBH	Output MBH	Water Content GPM
BLR-1	1,000	850	6.2
BLR-2	1,000	850	6.2

TABLE 4: HOT WATER PUMP SUMMARY

Pump	Operation	Motor (HP)	GPM
HWP-1	Duty	1	85
HWP-2	Standby	1	85
HWP-3	Duty	1	85
HWP-4	Duty	.5	170
HWP-5	Standby	.5	170

4. Discussion of Systems

The system in the building has both an air side and a water side. The RTUs supply air to VAV boxes that are controlled by thermostats located within the area they serve.

The supply fans will turn on when the thermostats reach a temperature below the set point of the zone. This set point will vary based on occupancy, and seasonal temperatures, the summer being the cooling season and the winter being the heating season.

The boilers provide the VAV boxes and RTUs with hot water to either heat or reheat the air as needed by each zone. They also provide the building with domestic hot water.

5. Proposed Alternative System

The proposed alternative system for the Berks Classroom and Lab Building will consist of implementing a ground source heat pump to the building. This will be compared to the existing system and a cost and pay back will be provided.

5.1. Ground Source Heat Pump

The heat pump would consist of an antifreeze solution pumped through pipes in the ground then back into the building. The pump relies on the constant temperature of the ground to supply the temperature differential needed to drive the heat exchange. The system will be implemented to replace the roof top units already in use. An expected saving on energy consumption of 25 – 50 % depending on climate with the implementation of

a ground source heat pump. It would be expected that this particular system would be closer to the 25% savings being located in South Eastern Pennsylvania. A comparison of cost to a similar geothermal system will be included, the system is located in South Western Pennsylvania, (ASHRAE, 2007).

6. Tools for Analysis

The tools for analysis for this project will include Trane Trace or equivalent program, RS Mean, scheduling software,

7. Breadth Proposals

7.1. Breadth One: Construction Management Breadth

This breadth will include a budget and schedule study of the ground source heat pump. This cost is more of a budget analysis that will be represented as a difference in budget of the current HVAC system and the ground source heat pump. The items to be included in the analysis will be the systems components and installation costs.

7.2. Breadth Two: Electrical Design

This analysis will consist of designing the electrical system for the ground source heat pump and any other equipment affected by its implementation.

8. Work Plan

1 Mechanical Depth Work
- 1.1 Research System – Semester break – 1/9/12
- 1.2 Design new system – 1/9/12 – 1/23/12
- 1.3 Construct new energy models – 1/9/12 – 1/23/12
- 1.4 Run energy models – 1/23/12 – 1/30/12
- 1.5 Analyze results – 1/30/12 – 2/13/12

2 Construction Management Breadth
- 2.1 Inquire about construction schedule – semester break – 1/9/12
- 2.2 Construct estimate – 1/23/12 – 2/13/12
- 2.3 Construct new schedule – 2/20/12 – 3/5/12

3 Electrical Redesign
- 3.1 Calculate Electrical loads – 3/5/12 – 3/19/12
- 3.2 Size components – 3/19/12 – 3/26/12

4 Final Report – 01/09/12 – 4/4/12

5 Presentation – 01/09/12 -4/9/12

9. BIBLIOGRAPHY

ASHRAE. (2007). *Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings.* Atlanta: ASHRAE.

RMJM Miller. (2009, July 17). Working Drawings for Berks Classroom and Lab Building. *Bid Documents* . Princeton, New Jersey, USA.