AE 482 Mechanical Project Proposal

Glen Burnie High School: Buildings D, E & F Glen Burnie, MD

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Executive Summary

Glen Burnie High School is a campus style high school located in Glen Burnie, MD. The campus is comprised of 6 buildings, but for the purposes of this proposal and the following project, only Buildings D, E & F will be considered. Building D is a constant air volume system served by unit ventilators, with fan coil units and cabinet unit heaters providing supplemental heating and cooling in corridors, stairways and storage areas. Building E is a constant air volume system served by 9 air handling units with convectors and cabinet unit heaters again serving as supplemental heat. There is also an individual unit ventilator serving the gymnastics area. Building F is the only variable air volume system of the three buildings and is served by 4 air handling units and 1 roof top unit. In the same manner as the previous 2 buildings, fan coil units and unit heaters are used for extra heating and cooling. Chilled water is supplied to Buildings D & F by chillers located in Building A. Building E is served by its own chiller. Heating water is supplied to all three buildings by steam boilers located in Building F.

The mechanical renovation that is currently in construction was required to increase performance and efficiency of the existing system by replacing and installing new equipment. Overall, the operation of the building's mechanical system adequately meets the required standards. However, in the process of design there were other options for the renovation that were either overlooked or decided against for one reason or another.

While the current system is sufficient, there is the possibility of utilizing ground source heat pumps at the risk of increasing the cost of the renovation. Using the ground occupied by the baseball and football fields, the system loops could be laid out which would reduce the required heating and cooling capacities of the larger equipment like chillers and boilers.

In addition to ground source heat pumps, changing the constant air volume system of Building E to a variable air volume system is an option as an extra way to save energy. This would provide the ability to adjust airflow to spaces on an individual basis rather than adjusting all spaces at once and using reheat to account for these inaccurate adjustments.

Building E's windows are in need of replacement due to age and poor thermal performance. A complete replacement of the existing windows would have an immediate effect on the HVAC loads as well as lighting. In addition to the replacement, a new window pattern is proposed for the gymnasium along with the installation of new windows to the Southern wall to allow for ambient lighting in the gymnastics area.

In the process of adding a ground source heat pump system, converting to a VAV system in Building E and performing a full window replacement, the cost and schedule of the renovation will need to be evaluated to check the possibility of performing these tasks without going grossly over budget or behind schedule.

Introduction

Glen Burnie High School is an existing campus style high school located in Glen Burnie, MD. It is a 6 building campus but this proposal and the following project will only consider the 3 buildings which are directly affected by the mechanical renovation. Building D is a typical classroom building housing the arts and acting arts classrooms, as well as a handful of foreign language classrooms. In addition to classrooms, there are a few faculty planning and conference rooms located around the building. The primary school gymnasium is located in Building E. This building also contains locker rooms, a weight room and a gymnastics area. The most diverse of the 3 buildings is Building F which contains the auxiliary gym and locker rooms on the east end of the building and business education classrooms filling the rest.

Design Objectives & Requirements

Because Glen Burnie High School was already constructed and in use, the purpose of the renovation was to upgrade some of the equipment and overall performance of the existing mechanical system. This created the need to maintain compatibility of the new equipment with the current. This was not the only restriction to the mechanical design that resulted from this project being a renovation. Since there was a system already in place, the energy sources which were in use before the renovation were favored to reduce the cost of switching to a new source. The selection of equipment was further limited because of dimensional requirements caused by existing mechanical spaces.

Existing Mechanical System Overview

Building D:

Building D's heating and cooling is supplied by 35 unit ventilators, 8 fan coil units, and 21 cabinet unit heaters. Unit ventilators are primarily located in classroom locations with the fan coil units serving the faculty areas and corridors. Supplemental heating is supplied to the corridors, stairwells and storage rooms by the cabinet unit heaters.

Chilled water is supplied to the building from chillers located in Building A. Unfortunately, since this building is not directly a part of the renovation, information could not be obtained. Hot water for the building is supplied by steam boilers located in Building F.

Building E:

Heating and cooling is supplied to the building by 9 constant air volume air handling units, 9 hot water convectors, 3 cabinet unit heaters and a single unit ventilator. As part of the renovation a new chiller was installed to supply chilled water to Building E. It will be

located outside of Building E in a separate chiller enclosure. Hot water for the building is supplied by steam boilers located in Building F.

Building F:

Building F is the only variable air volume system of the 3 buildings. Heating and cooling is supplied by 4 air handling units, 1 roof top unit, 2 fan coil units and 17 unit heaters. Chilled water for the building is supplied by the same chillers as Building D. Again, due to Building A not being a part of the renovation, information for the chillers could not be obtained. Hot water is once again supplied by the same steam boilers that serve buildings D and E.

Proposed System Alterations

The current mechanical renovation satisfied all requirements set forth in the pre-design phase. However, there are other options that could have been utilized but were not for one reason or another. These other options will be explored in the spring semester and examined using the existing system and renovation as a basis for comparison. The alterations to the mechanical system and building envelope will need to be evaluated for energy use, energy cost, compatibility, renovation cost and schedule.

Ground Source Heat Pumps:

As stated earlier, the campus energy is supplied by Baltimore Gas & Electric. However, in addition to natural gas and electricity, there is the possibility to utilize ground source heat pumps based on the available land space. This could be performed by installing the wells underneath the land occupied by the baseball and football fields. One of the biggest factors this will come into play in the alteration is the change in cost to the renovation. Also, the extra time needed to install the wells needs to be considered because of the possibility of interrupting the sports seasons by performing construction on the fields. With the addition of the heat pumps, a conversion from the constant air volume system in Building E to a variable air volume system might be considered.

Ground source heat pumps use the constant temperature of the Earth to provide favorable condensing and evaporating temperatures for the HVAC equipment. In the winter months heat is taken from the ground by the loops and transferred into the building through a heat exchanger. This can also be used in domestic hot water heating. In the summer months heat from the building is transferred through the heat exchanger to the loops and rejected into the Earth.

Proposed Breadth Topics

Architectural:

Building E is the Physical Education Building. It houses the primary gym, locker rooms, weight training room, wrestling room, and gymnastics area. The windows that are currently in place are in need of replacement due to age and poor thermal performance. It is proposed that the existing windows be replaced with newer multi-pane windows with better glazing and U-Values which will limit heat gain in the summer and reduce heat loss in the winter. In addition, new windows will be installed in the East, West and South walls of the building to provide the gymnastics area with sunlight and views to the outside. This will also create more window area for the main gymnasium resulting in more sunlight to the space. Performing this window replacement will have an effect on the HVAC design by changing the envelope loads experienced by the mechanical systems, the lighting of the spaces due to the increase in available ambient light, as well as the façade of the building itself. However, with the addition of a window replacement to the scope of work, the cost and schedule will once again increase. This leads to the final breadth area of study.

Construction Management:

In the process of adding a ground source heat pump system, variable air volume boxes and a window replacement to Building E, there will be changes to the cost and time of the renovation. An evaluation of the increase in schedule time will be performed and checked for the ability to limit the length of the renovation. While the installation of the geothermal wells will increase the length of the renovation, it would be possible to install the windows at the same time. This should limit the overall increase in the length of the renovation to that of the geothermal or window replacement alone. The cost of the new equipment and windows will inevitably cause the cost of the renovation to increase. However, the savings in energy and first cost by reducing the size of major equipment such as chillers will allow for a quicker payback time then by doing only individual pieces of the proposed alterations.

Tools For Analysis

In order to examine the effects on annual and monthly energy usage by the ground source heat pumps, Trane Trace will be used. In addition, the effects on the energy costs can be analyzed using Trace as well. Multiple analyses may need to be performed in order to accommodate the multiple systems which will be in place. For the architectural and construction management breadths, RSMeans will be used to examine the cost of new equipment and windows and the overall change in scheduling times. The latter will be modeled and represented using Microsoft Project. As a basis for comparison, the existing mechanical system and renovation will be used, along with the ASHRAE baseline building for energy use. ASHRAE standards will also be used to check the new HVAC system in comparison to the baseline for airflow and outdoor air percentages since there will be a new variable air volume system installed.

Appendix A: Preliminary Research

"CHARACTERISTICS, DEVELOPMENT AND UTILIZATION OF GEOTHERMAL RESOURCES." Oregon Institute of Technology, June 2007. Web. <http://geoheat.oit.edu/bulletin/bull28-2/art1.pdf>.

This article detailed the different types of geothermal resources and how they are utilized. It goes on to discuss the effects that a geothermal system can have, both positive and negative. There are cost and energy savings available, but there is the possibility of damaging the environment if not utilized properly.

"Geothermal Heating and Cooling." *Finger Lakes Institute*. Hobart and William Smith Colleges. Web. <http://fli.hws.edu/pdf/GEOTHERMAL%20HEATING%20AND%20COOLING.pdf>.

This article described the different components of a geothermal heating and cooling system. It then went on to explain the different ways that a geothermal heating and cooling system can be installed. There were descriptions of the different types of ground loops, from open and closed to horizontal and vertical, and how geothermal systems allow for the removal of other pieces of equipment from the heating and cooling system. The article finishes with a list of the advantages to using a geothermal system.

"Heating and Cooling with a Heat Pump." *Office of Energy Efficiency | L'Office De L'efficacité énergétique*. Natural Resources Canada, 20 Apr. 2009. Web. <http://oee.nrcan.gc.ca/publications/infosource/pub/home/heating-heat-pump/gsheatpumps.cfm>.

This article again described the parts of a geothermal heating and cooling system. It also stated that in addition to reducing the heating and cooling loads, a geothermal system can be used in a domestic hot water system. There were also brief descriptions of open and closed systems. The article concluded with a list of the benefits of a geothermal system

Appendix B: Spring Semester Work Schedule

In order to complete the main mechanical alterations as well as the two breadth areas of study, a diligent work plan must be constructed to keep on schedule. Below is the proposed work plan for the spring semester. Included are the main steps towards completing the final project and durations of research and processes. Also, several milestones have been marked in order to ensure that progress is kept on schedule.

Proposed Spring Semester Thesis Schedule

January 2011 - April 2011

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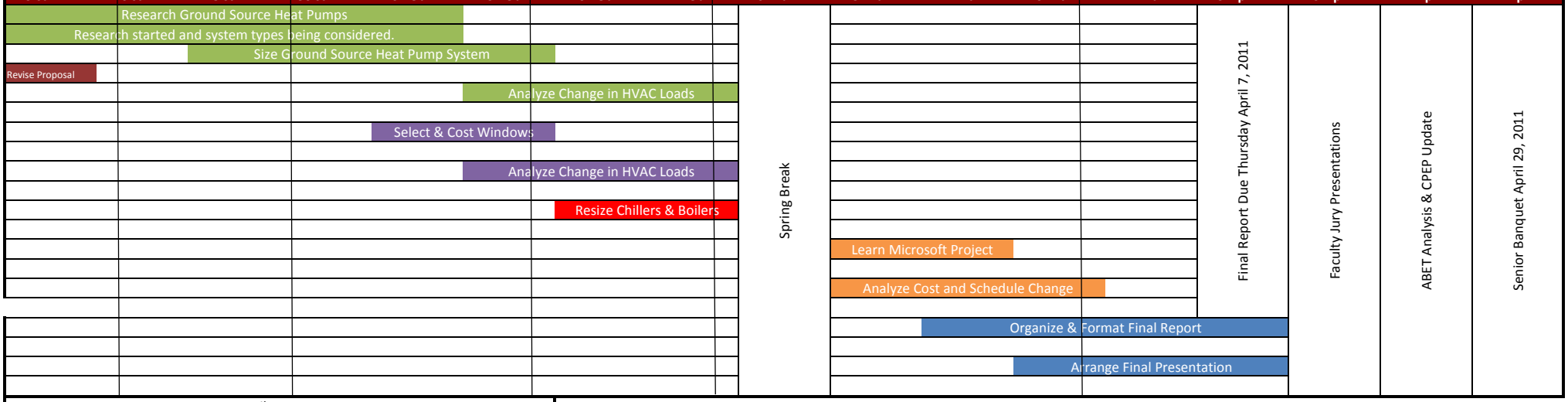
18-Jan-11	Milestone 1	Milestone 2	Milestone 3	Milestone 4
	31-Jan-11	18-Feb-11	4-Mar-11	25-Mar-11
Progress		Go-No Go		Go-No Go



Milestones	
1	Ground Source Heat Pumps preliminary system designed.
2	Ground Source Heat Pumps designed.
3	Architectural Breadth 95% complete.
4	CM Breadth 95% complete.

Mechanical Depth - Ground Source Heat Pumps
Architectural Breadth - Window Replacement
CM Breadth - Cost And Schedule Analysis