Proposal

CENTRAL HIGH SCHOOL MID-ATLANTIC REGION

ADAM BROWN

MECHANICAL OPTION

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Submitted 1/17/14

Contents

Executive Summary

Central High School is a modern and state of the art facility for students to learn and grow throughout their high school years. To further make this into an energy efficient and sustainable building multiple options are presented in this report to reach these goals.

Having researched other ideas, one option was selected for redesigning the building; a ground coupled heat pump system. The large surrounding area the school owns would provide enough space for geothermal wells to be drilled to provide cooling and heating throughout the year. Also the use of vertical heat pump units in the closet spaces within rooms give easy access for maintenance staff members. Furthermore the system will greatly reduce the emissions by eliminating mechanical equipment such as the natural gas fired boiler. It should be noted that the distribution pumps will be located in the mechanical room that is in the crawlspace below the first floor, assuming this space takes up the entire footprint of the building. The pumps will also need to fit into the space and be accessible by the maintenance staff.

By constructing a ground coupled heat pump system additional studies must be made to see how it impacts the building. With the vertical heat pump units being placed in mechanical closets in rooms, such as offices and classrooms, the noise generated by these pieces of equipment must be mitigated. A study will be done to see how to properly construct these mechanical closets in order to avoid acoustical problems. Also with the heat pumps being installed in these rooms it will incur new construction costs, schedule issues, and coordination issues compared to being installed in the ceiling. Therefore a matrix of these issues will be set up to compare whether installing the heat pumps in the mechanical closets or ceiling would be more feasible. The mechanical closet must be awarded 2 out of 3 categories in order to be feasible.

Building Overview

Building Description

Central High School is a newly renovated high school located in the Mid-Atlantic region. At roughly 320,000 square feet it is an impressive state of the art school with two levels the top one being the addition. The building has food and science labs, classrooms, offices, gyms and an auditorium to serve the learning needs of the occupants. It is expected to be completed by February 2015.

Mechanical System Overview

Twenty energy recovery units are located throughout the building that delivers outdoor air to fan coil units with recirculated air serving the zones. Along with that, two air cooled chillers and a boiler serve the energy recovery units and fan coil units.

Occupant and Project Team

Owner: Confidential

Construction Manager: Jacobs http://jacobs.com/

Architect: SHW Group, LLP http://www.shwgroup.com/

Structural Engineer: Adtek Engineers, INC. http://www.adtekengineers.com/

Mechanical and Electrical Engineers: SHW Group, LLP http://www.shwgroup.com/

Civil Engineers: Bowman Consulting http://www.bowmanconsulting.com/

Kitchen Consultant: Nyikos Associates http://nyikosassociates.com/

Acoustical and Technology: Polysonics Corporation http://www.polysonics-corp.com/

Depth Study – Alternatives

Having developed a better understanding of the current mechanical system in place there are two proposals for a re-design. A ground coupled heat pump system would take advantage of the large surrounding area, steady ground temperature, and decreased site emissions. It would also be easier for the maintenance staff to maintain since there are fewer moving parts allowing the life of the system to be extended. The other alternative would be a VRF system that would take advantage of the interior spaces by redistributing heat to the exterior spaces. It would also require less piping and less mechanical space to house the equipment.

Ground Coupled Heat Pump

One goal for the redesign would be the environmental impact the system would have. Cooling and heating capacity is taken from the ground and not from boilers or chillers, boilers being the ones to give off the most emissions. A ground source heat pump would reduce the amount of emissions by eliminating these pieces of mechanical equipment.

A ground coupled heat pump has few moving parts, distribution pumps and heat pumps being the main moving pieces. This allows for easier maintenance and maintainability for the maintenance staff of the school. The multiple chillers, cooling tower and boiler will require more upkeep over their life and require extensive upgrades as opposed to a series of pumps.

VRF

Central High School has both interior spaces and exterior spaces which would benefit from a variable refrigerant system. The refrigerant will take heat gained from interior spaces and move it the exterior spaces. This allows the building to use waste heat that would once be rejected to be used for heating exterior spaces and decrease demand on the boiler.

Cost effectiveness is another advantage of a VRF system. The refrigerant pipe sizes are smaller than those of chilled water pipes which lead to less cost when installing the system. Also large mechanical rooms are not required since small condensing units can be placed outside the building and evaporator coils are at the zone.

Depth Study – Selection

A ground couple heat pump system will be studied as the depth for this thesis.

Breadth Studies

Acoustic Redesign

The choice of heat pumps to be vertical units that are placed in closets within rooms is because of the easy maintenance access. These will pose an acoustical problem for the rooms and therefore a study must be done to see what wall types should be used to mitigate noise. ANSI standards for schools will be implemented as the design criteria for these closets.

Construction Breadth Ground Coupled Heat Pump System

A ground couple heat pump system will incur new costs and schedule changes compared to the previous system. Designing a mechanical closet for the heat pumps to be housed in will further these costs and schedule changes along with coordination issues. Therefore a matrix will be set up to see whether it is feasible to house the heat pumps in the ceiling or in the mechanical closets. RS Means along with additional materials will be used to decide the feasibility.

Tools and Methods

eQuest

eQuest will be used to evaluate the new ground coupled heat pump system against that of the current system in place. The current system will be used as a baseline to see how well the proposed system does.

RS Means

RS Means will be used to estimate the cost of construction for the heat pump installation and closets that will be built to house the heat pumps. Basic assembly costs from RS Means will be used to come up with the construction costs.

Additional Materials

To further develop the energy model and cost analysis ASHRAE and ANSI standards, AE class notes, and other documents provided by the construction and engineering teams will be implemented.

Research

Maryland Clean Energy Center. “Using Clean Energy - Geothermal”. Web. 3 December 2013.

Checket-Hanks, A. Barbara. “School’s HVAC System Mixes Maintainability With Efficiency”. *The News.* August 2006. Web. 3 December 2013.

Dinse, R. David, P.E. “Geothermal System for School”. *ASHRAE Journal*. May 1998. Web. 5 December 2013.

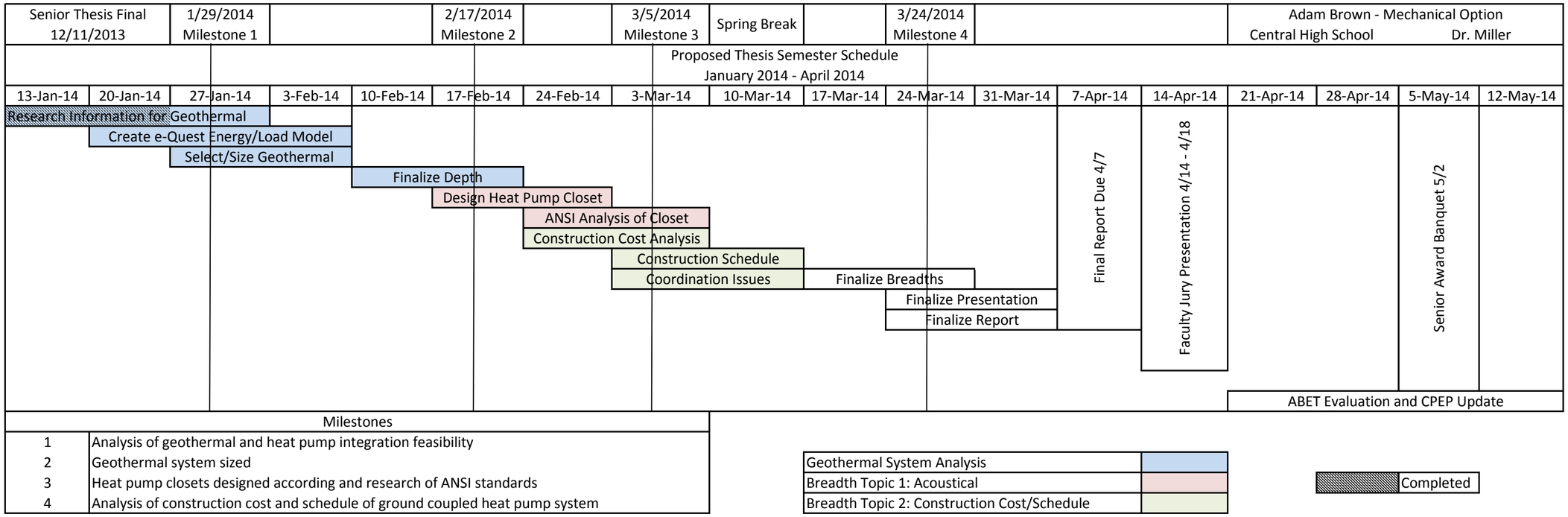
Bhatia, A. “HVAC Variable Refrigerant Flow Systems”. *CED Engineering*. Web. 5 December 2013.

Mitsubishi Electric. “VRF Zoning: A Flexible, Energy-Efficient HVAC System for Schools and Universities”. September 2012. Web. 5 December 2013.

References

SHW Group LLP “Final Bid Set”. Reston, Virginia.

Central High School “Master Specifications”.


Senior Thesis Final
12/11/2013
1/29/2014
Milestone 1
2/17/2014
Milestone 2
3/5/2014
Milestone 3
Spring Break
3/24/2014
Milestone 4
Adam Brown - Mechanical Option
Central High School
Dr. Miller
Proposed Thesis Semester Schedule
January 2014 - April 2014
13-Jan-14
20-Jan-14
27-Jan-14
3-Feb-14
10-Feb-14
17-Feb-14
24-Feb-14
3-Mar-14
10-Mar-14
17-Mar-14
24-Mar-14
31-Mar-14
7-Apr-14
14-Apr-14
21-Apr-14
28-Apr-14
5-May-14
12-May-14
Research Information for Geothermal
Create e-Quest Energy/Load Model
Select/Size Geothermal
Finalize Depth
Design Heat Pump Closet
ANSI Analysis of Closet
Construction Cost Analysis
Construction Schedule
Coordination Issues
Finalize Breadths
Finalize Presentation
Finalize Report
Final Report Due 4/7
Faculty Jury Presentation 4/14 - 4/18
Senior Award Banquet 5/2
ABET Evaluation and CPEP Update
Milestones
1 Analysis of geothermal and heat pump integration feasibility
2 Geothermal system sized
3 Heat pump closets designed according and research of ANSI standards
4 Analysis of construction cost and schedule of ground coupled heat pump system
Geothermal System Analysis
Breadth Topic 1: Acoustical
Breadth Topic 2: Construction Cost/Schedule
Completed