Proposal

CENTRAL HIGH SCHOOL MID-ATLANTIC REGION

ADAM BROWN

MECHANICAL OPTION

ADVISOR LAURA MILLER

Submitted 12/11/13

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.

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 new system being implemented it will incur new construction costs and schedule issues. Therefore a simple payback estimate will be done on the system to see if it is feasible from a financial standpoint. A schedule will be created to see how the construction time is impacted by this new system being implemented.

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 the school owns. It would also be easier for the maintenance staff to maintain since there are fewer moving parts. 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 greatly 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 Cost & Schedule for Ground Coupled Heat Pump System

A ground coupled heat pump system requires the drilling of wells which are not in place due to the current system. Also the addition of the heat pumps, new distribution pumps and heat pump closets will incur new costs and add more time to construction. Therefore a cost analysis must be done to see what the payback of this new system would be. A schedule of how the system would be put into place will be formed to see how it would affect construction time.

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 ground coupled heat pump system. This cost estimate will be used to perform a simple payback of the system to see if it is financially feasible.

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.

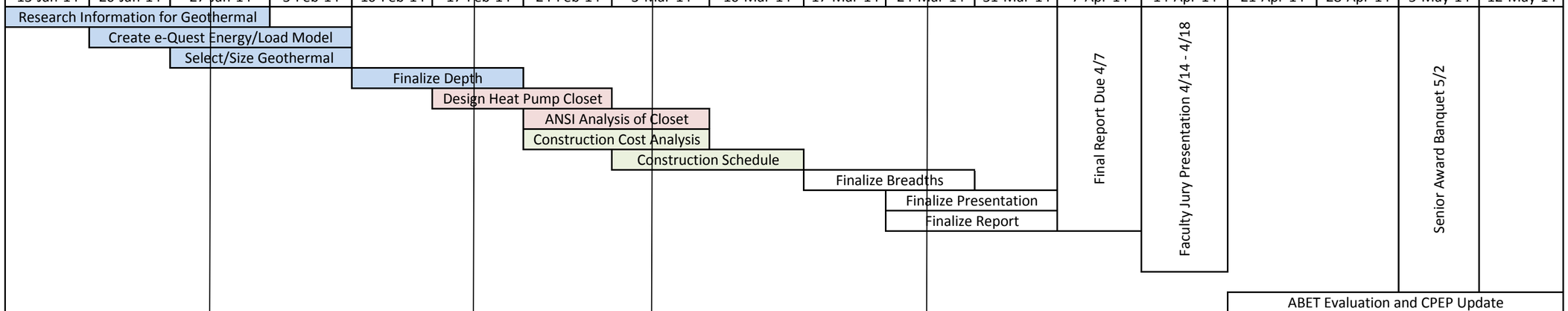
References

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



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	