A E 482

Thesis Proposal – Revision 1

The Teaching Center, Baltimore, MD

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Executive Summary

This report is the first version of a proposal for changing the design of the Teaching Center in Baltimore, MD. The changes will increase the energy efficiency of the building as well as decrease the operating costs in the long run.

The Teaching Center is a LEED Silver building which means it already complies with many strict codes and is very optimally designed. This made it challenging to propose redesigns, but some choices will give the Teaching Center the ability to help the environment and help the school's bottom line. The feasibility and the ability to adhere to strict codes were the two deciding factors while selecting proposals.

This proposal includes options for improving the mechanical system in the building along with the electrical system and acoustical environment. The mechanical system will be improved by adding variable exhaust systems to the teaching laboratories to reduce the operating costs for the exhaust fans. The acoustical environment will be analyzed by looking at reducing the noise created by the mechanical system and the partitions between rooms that have different requirements for speech privacy. The plumbing breadth will include looking at ways to harvest rain water and have that contribute to building systems.

Building Overview

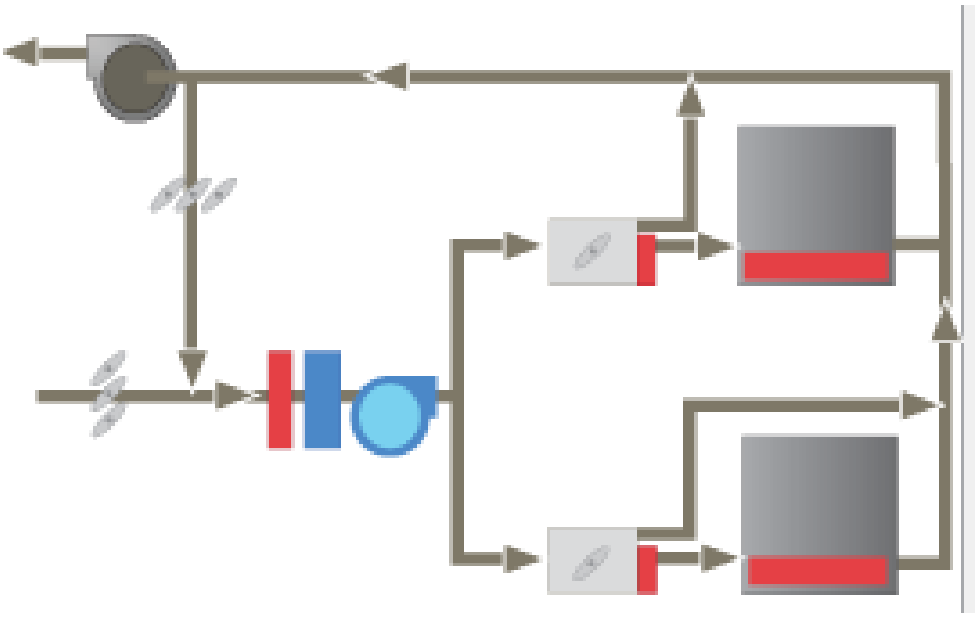
The Teaching Center is new academic building and will be the centerpiece of a new standard of teaching space for the campus. The 180,000-square-foot building will encourage active learning with state-of-the-art technology throughout its 22 classrooms and labs. It will also be home to the Academy of Innovation and Entrepreneurship and the new Teaching and Learning Transformation Center. Space for student interaction will be plentiful, including group study rooms, informal study space, and three cafés. The building is currently under construction and will be completed in the Fall of 2016.

The Teaching Center is a multi-building design that repurposes an old building on the campus and combines it with the new construction of the teaching center. The building with include many large and small classrooms as well as many teaching laboratories.

Mechanical System Overview

The air distribution system in the Teaching Center uses ten air handling units.

Four of the units are similar and distribute air to general areas such as, common areas, hallways and classrooms. Air Handling Units 1, 2, 5 & 6 serve these areas. They use an economizer and VAV system with an HRV-Wheel to recover heat, it also features 30% reheat.



Air handling Unit 1, 2, 5, & 6 schematic

Two of the units are used in teaching laboratories. Air Handling Units 3 & 4 are the same model, they are 100% OA systems and use Heat Exchanging pipes to recover heat.

Hot water and steam heat the building. Steam is provided off-site

Air Handling Unit 7 provides ventilation for the old building and is a Dedicated Outside Air System.

Below is an excerpt from the mechanical schedule that shows which Air Handling Unit serves certain areas. Below is an excerpt from the mechanical schedule that shows which Air Handling Unit serves certain areas. A more detailed look into the mechanical systems can be found in Technical Report 1,2&3.

DESIG	TYPE	SERVICE
AHU-226-0P-01	CUSTOM	LEVEL 1 WEST CLASSROOMS
AHU-226-0P-02	CUSTOM	LEVEL 2 WEST CLASSROOMS
AHU-226-0P-03	CUSTOM	EAST LABS (NORTH)
AHU-226-0P-04	CUSTOM	EAST LABS (SOUTH)
AHU-226-0B-05	CUSTOM	GROUND LEVEL WEST CLASSRMS
AHU-226-0B-06	CUSTOM	EAST CLASSROOMS
AHU-226-0G-07	MODULAR	HOLZAPFEL VENTILATION
AHU-226-0B-08	MODULAR	AHU BASEMENT MECH ROOM
AHU-226-0B-09	MODULAR	CHILLER BSMNT MECH ROOM
AHU-226-0B-10	MODULAR	ELEC ROOM

Depth Options

The Teaching Center will achieve a LEED Silver rating and is already pretty well designed. There are a few areas for improvement that may be viable. The main factors being considered in trying to change the design is the cost to benefit ratio, but all operating requirements for the building must be met .Below are the options considered for analysis:

Variable Refrigerant Flow (VRF)
This option could help improve the energy efficiency of the building by up to 30%. It would also save a lot of plenum space because instead of ducts, only refrigerant piping is present in the building, except for the ventilation. This also would help the aesthetics of the areas which do not have plenums by cutting down the amount of visible ductwork.

SUN Cooling Towers
This would be used to replace the cooling towers on the west roof. SUN Cooling Towers are the only Cooling Towers capable of net-zero energy consumption through the use of photovoltaic panels. The panels help run the cooling tower motors, and when they do not create enough energy, the balance can be drawn from the utility. SUN Cooling Towers are made by Evapco.

Figure 2: SUN Cooling Tower by Evapco

Variable Lab Exhaust
By varying the amount of exhaust used in the laboratories, the Teaching Center could see a 60% reduction in fan energy costs. This method would ensure proper air exhaust throughout the day and a variable frequency drive would increase the amount of air changes within seconds if an emergency situation arose. Using this would allow fans in areas that chemicals are not present in at night to have lower exhaust rates and save energy. Variable exhaust adheres to ANSI Z9.5 and BMS would be used for real-time system management. These systems also allow for LEED credit opportunities.

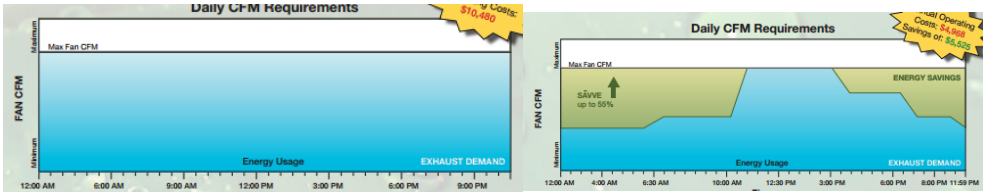


Figure 3: Daily CFM Requirements (Provided by GreenCheck)

Chilled Beams
This would improve the thermal comfort of the building and reduce energy usage, especially during summer months. It allows the air to naturally mix through the space. Chilled beams are typically an expensive option.

Proposed Depth

After considering the options, the decision was made to study the effects of installing variable lab exhaust in the teaching laboratories and adding VRF to occupied spaces. This will save the building energy and still meet the exhaust requirements for the building while also helping the building add LEED points which could move the building up to a LEED Gold rating. This option was also chosen for the education of learning more about laboratory exhaust systems considering higher education design is a large part of the industry. This will also be educational on the controls that work the exhaust system. There are multiple brands of variable exhaust systems, so considering the pros and cons of different products will also be studied. Adding VRF to occupied spaces should save energy by quickly being able to adjust in occupied spaces where the occupation varies throughout the day, such as classrooms, hallways, and offices.

Breadth Options

Acoustical Breadth
Because there are many different rooms with different uses, the acoustic properties of the rooms will be studied and suggestions will be made to achieve an optimal acoustical design. Building materials will be studied and will be altered to achieve this. Criteria like the NRC and reverberation timing will be tested. There will also be proposed realigning of rooms if loud rooms are too close to rooms where speech privacy is important. This will be important to the building because a building with so many rooms that have different uses needs to ensure an optimal acoustical environment.

Plumbing Breadth
Due to the considerable amount of annual rainfall in Baltimore, a study to analyze the benefits of water harvesting will be completed. Based on the amount of rain water harvested, there are many options for the uses of it. It could be used in water fixtures, such as toilets. If enough rain water can be harvested, there may be a possibility to have it contribute as a water-source heat pump. A climate study will be completed and after that, a cost analysis will be completed.

Additional Resources

Tools & Methods

Load and Energy simulation will be used intensively to compare the results of the original design with the proposed design. Trane TRACE 700 will be used to compare the two. Alternatives such as IES and EES will be used as well.

For the Acoustical Breadth, tools such as AIM, which will be used to critique the noise created by the mechanical systems will be used. CATT will help measure the clarity and the reverberation timing and general spreadsheets and charts made throughout the time spent here will be used to help perform the acoustical analysis for other criteria such as speech intelligibility and privacy.

The Plumbing Breadth will use Climate Consultant 6.0 to find the average annual and monthly rainfall.

Research

The following resources were used for research in this proposal.

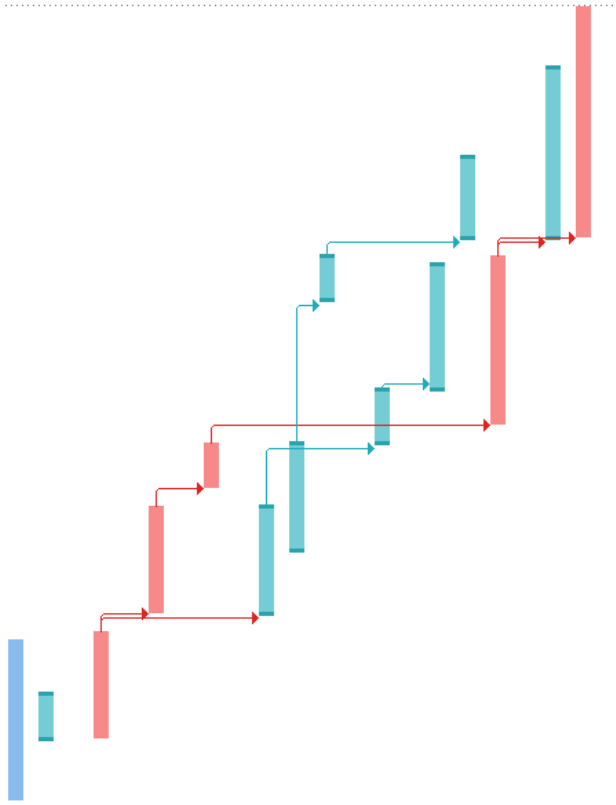
Batterman, Stuart A., and Harriet Burge. "HVAC systems as emission sources affecting indoor air quality: a critical review." *HVAC&R Research* 1.1 (1995): 61-78.

Frontczak, Monika, and Pawel Wargocki. "Literature survey on how different factors influence human comfort in indoor environments." *Building and Environment* 46.4 (2011): 922-937.

SUN Cooling towers http://www.evapco.com/products/sun_cooling_tower

Laboratory Exhaust Systems
<http://www.greenheck.com/media/pdf/catalogs/VektorHS_SAVVE_catalog.pdf>

Appendix A: Work Schedule



	Initial Research	14 days	Mon 1/4/16	Thu 1/21/16	
	Review and Revise Proposal	5 days	Mon 1/11/16	Fri 1/15/16	
	Review TRACE Model	10 days	Mon 1/11/16	Fri 1/22/16	
	New System to TRACE Model	10 days	Mon 1/25/16	Fri 2/5/16	3
	Select a Brand and Product for Depth	5 days	Mon 2/8/16	Fri 2/12/16	4
	Acoustical Analysis	10 days	Mon 1/25/16	Fri 2/5/16	3
	Lighting Analysis	10 days	Mon 2/1/16	Fri 2/12/16	
	Selecst New Lighting Products	5 days	Mon 2/29/16	Fri 3/4/16	7
	Select new Partitions	5 days	Sat 2/13/16	Thu 2/18/16	6
	Redesign Acoustics	10 days	Fri 2/19/16	Thu 3/3/16	9
	Redesign Lighting	7 days	Mon 3/7/16	Tue 3/15/16	8
	Complete Exhaust Redesign	15 days	Mon 2/15/16	Fri 3/4/16	5
	Presentation	15 days	Mon 3/7/16	Fri 3/25/16	12
	Write Report	20 days	Mon 3/7/16	Fri 4/1/16	12