The Ed Roberts Campus

Proposal

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Mechanical Option

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Contents

Executive Summary

The proposal outlines the investigation into possible alternative mechanical systems for the Ed Roberts Campus to be analyzed during the Spring semester. As the current system does meet all design and code requirements, and in many cases exceeds requirements, this is primarily an academic exercise investigating other ideas that may have been considered during the design process. When considering design alternatives for the building it was important to think about what other systems the proposed changes might influence. What benefits would the new system bring to the operation of the building? Additionally, it is important to consider costs associated with the installation and operation of the new system.

With these questions in mind the decision was made to investigate a Variable Refrigerant Flow system in the ERC. The current system is set up well to handle such a change, and there are many possible benefits in the efficiency and cost of operation. The system will be able to save some energy by eliminating chilled water HVAC equipment and still retain zone specific control of the indoor climate with the fan-coil units throughout the building. In addition, a solar thermal hot water system will be investigated to provide hot water to the radiant floor system. A heat exchanger between the refrigerant side of the HVAC system will allow water in this radiant system to be chilled.

The two breadth topics that will be investigated are tied to the removal of many pieces of equipment that were used previously for chilled and hot water in the HVAC system. A structural redesign of the roof system will be carried out to reflect the changed equipment loads on the roof. Additionaly, the electrical branch circuits serving mechanical equipment will need to be redesigned to reflect the change in equipment.

Building Overview

The Ed Roberts Campus is a 2-story, 80,000 sq. ft., transit-oriented community center located in downtown Berkeley, California. The campus is connected to a BART Station (Bay Area Rapid Transit) and is designed with a focus on accessibility for people with disabilities. Completed in 2011, the ERC is home to exhibition spaces, meeting spaces, a child development center, a fitness center, vocational training facilities, and offices.

Every square foot of the building is designed far and above the requirements of the Americans with Disabilities Act through a design concept called "Universal Design". Universal Design aims to create environments that are useful for people of all ages and abilities without additional cost. Extra-wide corridors, automatic doors, two-sided elevators are examples of this design ideal. In addition, the ERC's fully accessible connection to the BART station works to connect people directly to airports and bus stations around the city.

Leddy Maytum Stacy Architects

Existing Mechanical System

Airside Equipment

The airside equipment for the building includes five Air Handling Units, 59 zone-level water source heat pumps, and nine exhaust fans. AHU-1, AHU-3, and AHU-4 are constant volume units. AHU-1 serves the south end of the east wing and supplies 7,800 cfm. AHU-3 and AHU-4 serve the South and North, respectively, ends of the western wing, and supply 3,500 and 6,000 cfm of airflow. The final two air handling units utilize fans with Variable Frequency Drives, and thus supply varying volumes of air to the space. AHU-2 supplies the BORP office area with 5,500 cfm of air, and AHU-5 serves the courtyard area with 5,000 cfm.

AHU	Area Served	% Outside Air	CFM
AHU-1	East Wing - South	100	7,800
AHU-2	BORP	100	5,500
AHU-3	West Wing - South	100	3,500
AHU-4	West Wing - North	100	6,000
AHU-5	Covered Court	100	5,000

Water Source Heat Pump units manufactured by McQuay meet most of the cooling and heating loads of the building. The zones of the building are served by one of the following types of heat pump, based on the load requirements of the space, and there were a total of 59 units at design. Each unit contains one water coil for both heating and cooling needs. Each unit also contains one supply fan.

Since the ERC utilizes a 100% Outdoor Air system, all air is exhausted by nine fans that serve different areas of the building. Exhaust Fans 1, 3,4,5, and 7 serve the BORP Office and other general office spaces. EF-2 serves restroom exhaust requirements. The largest fan, EF-6, serves the entire basement level parking garage with 72,000 cfm of airflow. The remaining fans serve smaller electrical, elevator and garbage rooms.

Cooling and Heating Equipment

The cooling plant of the ERC's mechanical system is comprised of two rooftop cooling towers. Chilled water is used to supply the water coils in AHUs 1-4, all 59 of the zone level water sourced heat pumps, and the three zones of radiant flooring. The heating plant is made up of two boilers within the rooftop mechanical room. Hot water is supplied to water coils in all five AHUs, zone level water sourced heat pumps, and radiant flooring.

More detailed descriptions of this equipment and other related components can be found in Technical Report 3.

Proposed Alternatives

The following is a list of options that were considered as possible areas of investigation for the Ed Roberts Campus. It is important to note that while alternatives are being suggested, they are not suggesting that the current design is inadequate in any way. This is an academic exercise to explore energy use of different mechanical systems.

1. Implementation of on-site renewable energy sources
   a. Solar Panels (electricity or heating demand)
   b. Geothermal Heat Pump system
2. Use of all VAV AHUs in current system set up
3. Use of an economizer for the airside system
4. Conversion to a Variable Refrigerant Flow System

Each of these alternatives would offer different challenges and comparisons with the current system. Options 2 and 3 are likely too small in scope to offer an appropriate amount of work and therefore will not be selected. Similarly, Option 1 will likely not offer a significant enough change to the mechanical system to be used as a primary investigation. Therefore, Option 4 will be selected.

Depth

Variable Refrigerant Flow

For the Mechanical Depth portion of the thesis project, I will look into the effects of converting the current mechanical system into a Variable Refrigerant Flow system. Initial research indicates that the current system is already set up well for conversion to such a system. The Water Source Heat Pumps installed around the building will be converted to ceiling concealed fan coil units and serve separate zones. New air-source/condensing units will need to be installed on the roof to cool or heat refrigerant as the system demands, and new refrigerant lines to the fan coil units will need to replace old CHW/HW piping.

If this system is implemented, there could be great potential for energy savings. At very least it will be useful to compare the energy use of this kind of system to the actual energy use of the current building. The new system will not require any equipment to cool/heat water, so this equipment (cooling towers, boilers, chillers, etc…) could be removed from the rooftop mechanical room. In addition, the AHUs on the rooftop will only need to provide enough air for ventilation purposes and could possible be replaced with smaller ventilation-only units. These equipment changes, together with a good control and operations scheme, offer the possibility for great energy savings for the building.

The tools required in this section of the thesis investigation will include energy modeling software, such as Trane Trace, to track the changes in mechanical system within the building.

Solar Thermal Hot Water

As a secondary consideration, I would like to look into the possibility of implementing a solar thermal heating system for hot water demand in the building. The radiant floor system that conditions the lobby and courtyard spaces in the building will also be affected by the conversion to a refrigerant-only HVAC system because it still requires that water be used, so an energy efficient means to keep that system operational would be beneficial for the builing. The radiant system would still need chilled water, so a means to exchange heat with the VRF system would be a possible solution.

Breadth

Structural Breadth

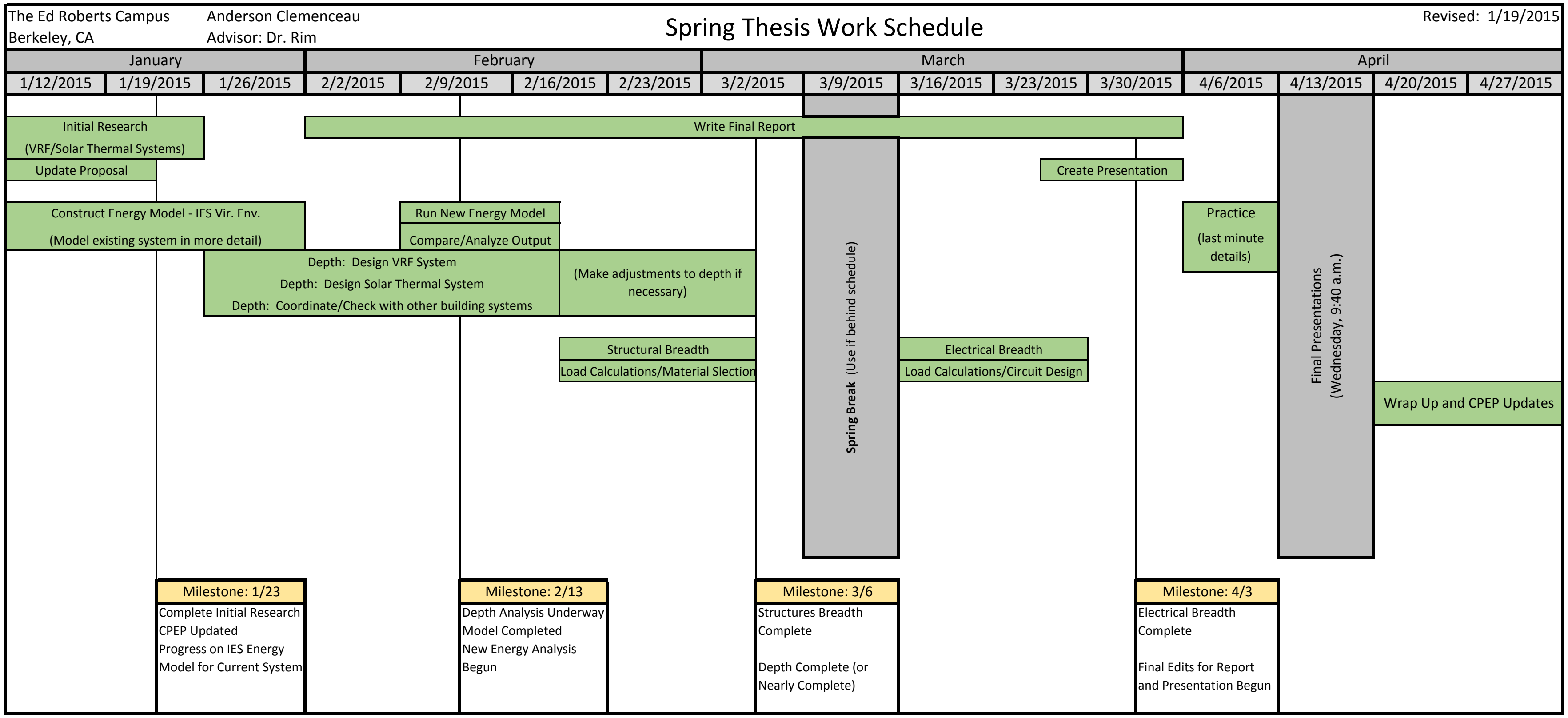
The removal of several types of chilled and hot water equipment from the rooftop mechanical room, as well as the possible downsizing of air handing units on the roof, offer the possibility of redesigning the structure of the roof. If the equipment loads on the roof are reduced, there is the potential for first cost savings over the original roof structure.

Electrical Breadth

Another possible effect of elimating equipment is an adjustment to the electrical system. This adjustment could mean redesigning a branch circuit, or the design of a completely new circuit, to suit the changing mechanical system. This change could result in a lower first cost for the electrical equipment, as well as a reduction in electricity use and monthly energy savings.

Tools

All of the above investigations will require software tools to completely analyze the proposal. Energy modeling software, such as Trane Trace, will be used to model the energy use within the building after the changes have been performed and compare back to the initial energy analysis in Technical Report 2. A more detailed analysis may be performed with the use of IES Virtual Environment. Additionally, calculations may be performed with the aid of Engineering Equation Solver (EES).



The Ed Roberts Campus
Berkeley, CA
Anderson Clemenceau
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Spring Thesis Work Schedule
Revised: 1/19/2015
January
February
March
April
1/12/2015
1/19/2015
1/26/2015
2/2/2015
2/9/2015
2/16/2015
2/23/2015
3/2/2015
3/9/2015
3/16/2015
3/23/2015
3/30/2015
4/6/2015
4/13/2015
4/20/2015
4/27/2015
Initial Research
(VRF/Solar Thermal Systems)
Update Proposal
Write Final Report
Create Presentation
Construct Energy Model - IES Vir. Env.
(Model existing system in more detail)
Run New Energy Model
Compare/Analyze Output
Practice
(last minute details)
Depth: Design VRF System
Depth: Design Solar Thermal System
Depth: Coordinate/Check with other building systems
(Make adjustments to depth if necessary)
Spring Break (Use if behind schedule)
Final Presentations
(Wednesday, 9:40 a.m.)
Structural Breadth
Load Calculations/Material Slection
Electrical Breadth
Load Calculations/Circuit Design
Wrap Up and CPEP Updates
Milestone: 1/23
Complete Initial Research
CPEP Updated
Progress on IES Energy
Model for Current System
Milestone: 2/13
Depth Analysis Underway
Model Completed
New Energy Analysis
Begun
Milestone: 3/6
Structures Breadth
Complete
Depth Complete (or
Nearly Complete)
Milestone: 4/3
Electrical Breadth
Complete
Final Edits for Report
and Presentation Begun