Technical Assignment 4

Thesis Proposal

City of Hope: Amini Medical Center

Duarte, CA

Christopher Bratz
Pennsylvania State University
Architectural Engineering
Mechanical Option

Faculty Advisor:
Dr. Jelena Srebric

January 19th, 2009

Table of Contents

Executive Summary

The past semester has been dedicated to providing an analysis of the existing mechanical conditions related to the Amini Medical Center. This report will briefly discuss the existing mechanical systems then address the depth and breadth redesign scenarios.

The proposed redesign of the Amini Center's mechanical system will begin by taking the system off the central and providing an independent chiller and pump package to serve as the buildings primary loop. This remodeled system will serve as the buildings existing system for comparison. From there three ice storage scenarios will be evaluated to decrease the annual cost seen by the building owner. The ice storage system will decrease the demand load from chiller during the high priced on-peak hours by shifting the load to non-peak hours where energy is cheaper.

In order to compare these systems, assumptions and models will be made using the TraneTrace 700 simulation program. After all scenarios are researched and the energy models are complete, a comparison between the systems will be made. Validation or rejection of the redesign will be the resulting conclusion of the comparison. A schedule for the work to be performed is presented at the end of this report.

One breadth area I propose will be reducing the lighting power densities while maintaining light levels prescribed by IESNA. The other breadth topic will include a structural analysis adding the chillers to the roof structure. The lighting changes will require evaluation of cost, energy consumption and lighting levels on the work plain. The structural study will focus on the bay where the chillers will be located. I will re-evaluate the loads and determine if the beams are sized correctly.

Proposal Objective

The purpose of this thesis proposal is to provide alternate design scenarios for the Amini Medical Center that will be extensively researched, designed, and compared to the existing design. The design comparison will include, but not limited to, system first cost, annual operation cost, maintenance, feasibility, and energy consumption. These alternate design concepts in no way suggest the original design to be flawed; they merely provide alternate scenarios to analyze and apply knowledge gained from the past few years of schooling.

Existing Mechanical Systems Overview

For an extensive description of the Amini Medical Center's existing mechanical systems, please refer to Technical Assignment 3. The following overview contains only information relevant to the proposed changes.

Cooling Plant & Building Cooling System

Cooling Plant

The Amini Center is served by a central plant composed of three centrifugal water cooled chillers and one steam absorption chiller. The system is a primary/secondary system providing chilled water for a good portion of the campus. The plant capacity is a nominal 7,150 Tons supplying a primary loop of 13,104 gpm and a secondary loop of 12,600 gpm. The points of connection for the Amini Center are a 12" chilled water supply (CHWS) and a 12" chilled water return (CHWR) lines located at the South end of the building.

Building Cooling System

The CHWS & CHWR lines enter/leave a mechanical room on the first floor of the building. According to the designers load calculations, only 6" CHWS & CHWR lines were necessary to serve the Amini Center. The chilled water entering the building is supplied at 42^{o}F.

Two secondary pumps located in the first floor mechanical room provide circulation of the chilled water to the AHU and FCU cooling coils throughout the building.

Control Features

Controls and sequences of operation play a large role in the overall scheme to achieving energy savings, occupant comfort, and proper IAQ. Some of the control features for the Amini Medical Center can be seen below.

General Control Features

The building is equipped with automated DDC system.

Due to the VFDs on the chilled water pumps, 2-way valves are provided on the cooling coils to take advantage of pump savings when possible.

Sequences of Operation
Chilled Water Plant/Pumps

On a call for cooling by any one of the air distribution systems, the chilled water valve shall open and both pumps shall energize. Pump VFDs shall modulate to maintain differential pressure setpoint. Upon failure of one pump, the other shall operate to maintain necessary setpoint.

Building CHWS and CHWR temperatures shall be monitored. If the differential temperature is above the setpoint by 15°F, then the chilled water bypass valve shall open. If the differential temperature setpoint is 9°F or less, then the chilled water bypass valve shall close.

Depth Redesign Proposal

Proposal

The depth of research and design for this thesis is planned to focus making the Amini Center cooling system independent from the rest of the campus. The design will have the existing building system as a primary/secondary system with an air cooled chiller. The redesign will employ an air-cooled chiller with ice making capabilities and an ice storage tank on the primary loop. By installing this, I hope to reduce the annual operating costs for the building by shifting the on-peak cooling load to off-peak hours.

Justification

Utility companies charge higher rates during high demand hours. These times usually occur during the summer and in the afternoon. This is true for the Amini Center’s utility company which charges an additional $10/kW during on-peak times compared to mid-peak hours. The off-peak demand charge is $15/kW less then the on-peak demand charge. By installing this type of system and shifting the on-peak load to off-peak hours would save the owner $15/kW.

Integration & Coordination

Due to changes to the cooling system, chiller and pump sizing will be a factor that will need to be evaluated. It is believed that the new design will be able to reduce the size of the chiller and primary pumps.

Breadth Redesign Proposals

Electrical Proposal

Throughout the Amini Center, many T8 lighting fixtures are implemented. Due to strict lighting power densities and the attempt for LEED Gold certification, better lighting fixtures will be looked at in order to reduce the energy consumption of the building. In many of the office area where T8 fixtures are dominant, T5 fixtures will be looked at to reduce wattage while maintaining an equal lighting level. The cost, energy consumption, and lighting levels will be evaluated.

Structural Proposal

Due to the size and type of equipment being selected in the redesign, locating them on the roof will increase the load and the beams will need to be evaluated. The bay where the chillers will be located will be evaluated and increased of necessary, for the new loads.

Tools & Methods

To evaluate the load, cost, and energy effects associated with the redesign; TraneTrace 700 software will be used. In order to use this program, many assumptions will have to be made regarding the existing system and the redesigned system. Because little is know about the central cooling plant, a base model will need to be simulated for annual energy consumption. The redesigned system will be evaluated for first cost, and simulated for annual energy consumption and cost. The results will then be compared and discussed.

Schedule

Please refer to Appendix A for schedule of work.

References

ASHRAE. 2008, 2008 ASHRAE Handbook – HVAC Systems and Equipment. American Society of Heating Refrigeration and Air Conditioning Engineers, Inc., Atlanta, GA. 2001.

American Standard Inc. 2002. Trane Engineers Newsletter – Vol. 31, No. 4. Trane, La Crosse, WI

Appendix A
Spring Semester Schedule

January 2009

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
				1 New Year's Day	2	3
4	5	6	7	8	9	10
11	12 **Classes Resume**	13 Fix Energy Model for existing conditions	14 Fix Energy Model for existing conditions	15 Fix Energy Model for existing conditions	16 Fix Energy Model for existing conditions	17 Fix Energy Model for existing conditions
18 Fix Energy Model for existing conditions	19 Martin Luther King Jr.'s Birthday	20 Research VPF System and Begin Design	21 Research VPF System and Begin Design	22 Research VPF System and Begin Design	23 Research VPF System and Begin Design	24 Research VPF System and Begin Design
25 Research VPF System and Begin Design	26 Research VPF System and Begin Design	27 Research VPF System and Begin Design	28 Research VPF System and Begin Design	29 Research VPF System and Begin Design	30 Research VPF System and Begin Design	31 Research VPF System and Begin Design

February 2009

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1 Research VPF System and Begin Design	2 Perform Cost information on redesign	3 Perform Cost information on redesign	4 Perform Cost information on redesign	5 Perform Cost information on redesign	6 Perform Cost information on redesign	7 Perform Cost information on redesign
8 Perform Cost information on redesign	9 Compare Results and look for errors	10 Compare Results and look for errors	11 Compare Results and look for errors	12 Compare Results and look for errors	13 Compare Results and look for errors	14 Compare Results and look for errors
15 Begin Electrical Breadth	16 Presidents Day	17 Begin Electrical Breadth	18 Begin Electrical Breadth	19 Model New lighting Design separate form other redesign	20 Model New lighting Design separate form other redesign	21 Model New lighting Design separate form other redesign
22 Record data and make comparison	23 Record data and make comparison	24 Record data and make comparison	25 Record data and make comparison	26 Begin Acoustical Breadth	27 Begin Acoustical Breadth	28 Begin Acoustical Breadth

March 2009

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1 Begin Acoustical Breadth	**2** Begin Acoustical Breadth	**3** Begin Acoustical Breadth	**4** Begin Acoustical Breadth	**5** Begin Acoustical Breadth	**6** Begin Acoustical Breadth	**7** Begin Acoustical Breadth
8 Write up Acoustical Breadth	**9** Write up Acoustical Breadth	**10** Write up Acoustical Breadth	**11** Write up Acoustical Breadth	**12** Finish All modeling	**13** Finish All modeling	**14** Finish All modeling
15 Finish All modeling	**16** Finish All modeling	**17** Finish All modeling	**18** Finish All modeling	**19** Work on Final Report	**20** Work on Final Report	**21** Work on Final Report
22 Work on Final Report	**23** Work on Final Report	**24** Work on Final Report	**25** Work on Final Report	**26** Work on Final Report	**27** Work on Final Report	**28** Finish Final Report
29 Work on Presentation	**30** Work on Presentation	**31** Work on Presentation				

April 2009

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
			1 Work on Presentation	2 Work on Presentation	3 Work on Presentation	4 Work on Presentation
5 Last minute Final Report fixes	6 Last minute Final Report fixes	7 Last minute Final Report fixes	8 Final Report Due	9 Finish and practice presentation	10 Finish and practice presentation	11 Finish and practice presentation
12 Finish and practice presentation	13 Presentation Day	14 Presentation Day	15 Presentation Day	16 Presentation Day	17 Presentation Day	18
19	20	21	22	23	24	25
26	27	28	29	30		