Proposal

A E 481W | Senior Thesis Project

1/20/2009
Mechanical Option
Anly Lor

»*Prepared For*: James D. Freihaut, PhD, Associate Professor

»*Building Name*: Sinai Hospital South Tower Vertical Expansion

»*Building Location*: 2401 W. Belvedere Ave. | Baltimore, MD 21215

Table of Contents

Executive Summary

The proposal for the redesign of the mechanical systems in the Sinai Hospital South Tower Vertical Expansion includes the newly designed chilled water plant and the previously installed domestic water system. In the first phase, thermal energy storage is employed in order to utilize load shifting in order to reduce peak demand. For a hospital, this would offer significant benefits since a major amount of air conditioning is required. During the second phase, the domestic water system would be retrofitted with a solar hot water heating system. Again, there would be significant benefits, as the quantity of hot water used in the hospital is substantial.

Consequently, these additions may significantly alter other aspects of the building's design, including the structural and electrical systems. The dead load added by new equipment may jeopardize the integrity of the structural support of the building, so it must be analyzed. Additionally, the new equipment will increase the requirement for additional power, which entails a thorough inspection of possible changes in the main electrical distribution system. Panelboards and emergency power may need to be reworked.

The complexity of these revisions the Sinai Hospital South Tower Vertical Expansion requires attention to integration and coordination. The existing systems must be retrofitted in way such that the economic benefits are achieved. System controls will need updating, as the redesign of both the chilled water plant and the domestic water system vastly alters the systems. Extensive research must be performed to ensure these implementations are viable. In order to so, existing data from design documents, and data obtained in previous reports must be utilized to the fullest extent. If necessary, new calculations must be performed. In the event that justification for this redesign turns out to be poor, the educational benefits gained will be worthwhile.

Existing Systems

Overview

The Sinai Hospital South Tower Vertical Expansion is a three-story addition to the existing three-story tower. It retains the shape of the current footprint. In addition, a six-story link enclosing a four-story atrium lobby connects the expansion to the existing North Tower. An elevator tower and a helipad have also been constructed. Each floor has its own unique function. The fourth floor houses the intensive care unit. The fifth floor will be the future home of traumatic brain injury care and sterile processing. Lastly, the intermediate care unit is located on the sixth floor.

Air-Side

The addition is served by two new custom-fabricated air handling units, providing an additional capacity of 146,000 cfm. Two existing air handling units located on the third floor roof are relocated to the sixth floor roof and provide redundancy. All of the occupied spaces will be heated and air conditioned with the exception of the penthouse. Design conditions for this equipment are 0°F dry bulb in the winter and 95°F dry bulb and 79°F wet bulb in the summer. The spaces are ventilated in accordance with current AIA, DHHS, and ASHRAE guidelines. The supply and return air in the distribution system for all three floors was designed at medium pressure and variable air volume. Individual supply air terminal units are provided for each patient room. Airborne infectious isolation rooms are also provided exhaust air terminal units and their own dedicated exhaust air system.

Water-Side

The existing heating plant is located in the ground floor mechanical room. The existing 4" heating hot water mains provide adequate infrastructure for the expansion. They were sized with the future addition of the fourth, fifth, and sixth floors in mind. The capped risers are located in the mechanical chase south of the service elevator and have been extended vertically through the addition from the third floor. However, a new chilled water plant is required and has been designed to provide the additional cooling capacity. The plant includes a 2,000-ton centrifugal chiller, cooling tower, and chilled and condenser water distribution pumps. It is located in the penthouse.

All systems will be commissioned, tested, and balanced in accordance with AABC standards.

Proposed Redesign

Thermal Energy Storage
(Satisfies M.A.E. Requirement)

The first part of the redesign that will be explored is a retrofit of the building's chilled water plant. A thermal energy storage tank will be added to the existing design. This may require an addition of a glycol loop for charging and discharging.

With thermal energy storage, cooling capacity is stored for later use, allowing for economic and operational benefits. Although there may be a higher first cost, the ability to shift loads will reduce peak demand and offer significant electric utility savings due to the large amount of air conditioning required in the hospital. The impact of energy consumption and both first cost and operating costs will be evaluated. In addition, the maintainability and reliability of thermal energy storage is very good.

Solar Energy

The second part of the redesign that will be explored is a retrofit which utilizes solar energy and solar collectors to supplement the hospital's heating systems. With the substantial amount of hot water used by the hospital every day, these solar collectors will offer a significant electric utility savings similar to the benefits of thermal energy storage. First costs may be higher here as well, but operating costs in the long run will be considerably reduced. However, additional pumps, fittings, and other equipment may be required.

Not only will this proposed redesign provide economic benefits, it also allows for the chance to learn about the advantages and challenges of a renewable energy system, which may be an important consideration for buildings, especially large energy consumers, in the future.

Breadth Topics

Structural/Architectural

The inclusion of a thermal storage tank and possibly an additional hot water heater will add to the dead load of the building. Both components, in addition to smaller, miscellaneous equipment such as pumps, will add significant weight. This will require an analysis of the hospital's structural support. As of now, both the thermal storage tank and hot water heater are proposed to be located in the penthouse or on the sixth floor roof. Depending on the required size of the equipment (following the mechanical redesign), additional space may be needed.

Electrical

With the addition of new equipment, there is requirement for additional power as the electrical load will change. Possible changes to the main distribution system and panelboards need to be analyzed. Although emergency power for the vertical expansion is already available from a new generator installed on the project, the system will need to be reworked in order to supply the new equipment.

Integration & Coordination

For the first phase of the redesign (utilizing thermal energy storage), coordination with the existing chilled water system is crucial. The thermal storage tank needs to be integrated with the chillers so that charging may occur during low peak demand and discharging may occur during high peak demand. Depending on the type of thermal energy storage used, a glycol loop may also need to be implemented. Since the inclusion of the thermal storage tank into the existing chilled water system is a major requirement, the tank should be located as close as possible to the chillers. This will help reduce the length of piping required in the retrofit as well as reduce any additional pumping head needed. Controls will need to be updated in order to provide functional operation. Without proper controls, chilled water temperature may become inaccurate and could be disastrous to the correct system function.

For the second phase of the redesign (utilizing solar energy), coordination with the existing domestic water system is very important. The implementation of solar collectors will require integration with the existing domestic water system, using the infrastructure already in place. Because the existing hot water heater is located in the South Tower basement, it may need to be relocated or an additional hot water heater may need to be provided closer to the solar collectors. Additional pumps may be required to move water through the collectors and various fittings will need to be installed. The controls will also have to be updated in this phase.

The major equipment for both phases must be properly insulated.

Tools & Methods

The modifications of the chilled water system and the domestic water system will require a great amount of detail of existing system data. This will allow for proper selection of equipment, including but not limited to the thermal storage tank, solar collectors, and possible hot water heater. Equipment will be selected through manufacturers' websites. Existing data will be obtained from design documents, and if not available, previously performed analyses using Trane's TRACE 700 software. Data unavailable from both methods will be calculated using other software available, including Microsoft Excel and Engineering Equation Solver.

For economic comparisons, first and life-cycle costs will be taken into consideration when comparing the proposed redesign and the existing systems. Again, data will be taken whenever provided; otherwise, it will need to be calculated. For the first phase, electric utility rates must be carefully analyzed in order to obtain accurate values which may impact this economic analysis. Because load shifting and peak demand are integral reasons for using thermal energy storage, much attention to detail must be given to this area. For the second phase, solar studies may need to be performed in order to determine the amount of solar energy available to the collectors. This directly impacts the economic benefits of this part of the redesign. Extensive research on solar angles and directions must be performed for the Sinai Hospital South Tower. These comparisons will either justify the decision for the proposed redesign or at least have been a valuable learning experience.

Once a preliminary study of the mechanical systems redesign has been completed, work may begin on the breadth topics outlined in this report. Structural and electrical systems outlined in the designed documents must be studied and revised accordingly with respect to the obtained results of the redesign. In addition, all revisions must comply with local and national building codes.

Work Plan Draft

*Finish assignment by end of week

»*January*

Week	Assignment
11th – 17th	Proposal revisions, preliminary research
18th – 24th	Thermal energy storage
25th – 31st	Thermal energy storage

»*February*

Week	Assignment
1st – 7th	Solar energy
8th – 14th	Solar energy
15th – 21st	Equipment selection
22nd – 28th	Cost analysis

»*March*

Week	Assignment
1st – 7th	Cost analysis
8th – 14th	Electrical breadth
15th – 21st	Electrical breadth/Structural breadth
22nd – 28th	Structural breadth
29th – 4th	Final report

»*April*

Week	Assignment
5th – 11th	Presentation
12th – 18th	Faculty jury
19th – 25th	-
26th – 2nd	-

*Semester Ends May 1st, 2009

Preliminary References

Nagengast, Bernard. “A History of Comfort Cooling Using Ice.” ASHRAE Journal February 1999: 49-55.

“Solar Hot Water.” 17 May 2006. <http://www.eere.energy.gov/de/solar_hotwater.html>.

Sullivan, C.C. “Thermal energy storage brings operational efficiency.” 1 February 1999. < http://www.allbusiness.com/construction/construction-buildings/490293-1.html>.

Turpin, Johanna R. “Thermal storage and perpetual savings.” July 2002. < http://findarticles.com/p/articles/mi_m0BPR/is_7_19/ai_89490488>.

Walker, Andy. “Solar Water Heating.” National Renewable Energy Laboratory 23 May 2008.