Mechanical Proposal

Thesis Redesign Proposal

UNLV Greenspun Hall

Las Vegas, Nevada

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Mechanical Option

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Executive Summary

The current mechanical system for UNLV Greenspun Hall is typical evaporative cooling distributed system that utilizes chilled beams for energy efficiency. Through research, a new cooling system will be designed to increase innovation and efficiency. In this document, alternative system components and designs were explored to accomplish this goal.

The chosen alternative is an absorption chiller setup, which is driven by solar absorbers supplying energy to the generators, to replace the current chillers. This and the addition of a thermal storage tank will decrease electricity consumption, thus reducing operating cost. Although the initial construction cost of such a system will be greater than the original design, lower operating costs will allow for a reasonable payback period.

Through various load analyses and research, the proposed redesign will be accomplished and studied according to a tentative work schedule. A final presentation will fully address comparisons between the old and new designs and their corresponding advantages and disadvantages.

Existing System Description

The chilled water system for UNLV Greenspun Hall is a primary/secondary system which consists of a heat rejection loop and load loop. Air is supplied through five air handling units, four of which are roof top units, and three of which are 100% dedicated outdoor air. Air is first filtered through 2" prefilters and then through pleated MERV-13 rated filters before pre-conditioning through the coils in the air handlers, where air dry bulb temperature is reduced from roughly 100 F to 50 F. It is then distributed to the various zones, where chilled beams can supply further cooling if necessary to meet the load by the same supply of chilled water that the cooling coils in the air handlers used for pre-conditioning.

After being distributed to each of the various zones and spaces, air is then collected in the plenum. In the case of a zone needing additional cooling not sufficiently met by the primary system, the secondary system of fan coil units circulate the air over their respective cooling coils and supply it back to that particular zone. Most of the plenum air is delivered back to the air handlers through hallway plenum return and vertical shafts.

UNLV Greenspun Hall's mechanical system has two Carrier 19XR centrifugal chillers and one 300 MBH Plate Heat Exchanger which supply chilled water to the air handling units, chilled beams, and fan coil units. This is accomplished by circulating condenser water through the heat rejection loop which supplies cooling to the chilled water loop to circulate back to the loads.

Condenser water is circulated by the pumps, from the chiller to the cooling towers, where heat is rejected through evaporation. The cooler condenser water is then re-circulated back to the chillers. Each open-celled cooling tower has its own basin filter and is chemically treated to reduce the chance of contamination.

Considered Alternatives

The aspiration of the designers for UNLV Greenspun Hall was to utilize their design objectives, energy efficiency and innovation, to achieve their goal of LEED Gold Certification. However, they fell short of their goal and received LEED Silver. The list of alternative redesign options below describes the utilization of other equipment and layouts to improve efficiency.

- *Green Roof*
  A large portion of the cooling load's source is from direct sunlight. The remainder of the load is created by the ambient outdoor temperature, infiltration, and internal gains. The use of a green roof could lead to a large decrease in this load. However, maintenance and operational costs, including water, in this climate would render this inconceivable.
- *Energy Recovery Wheels (Desiccants)*

Pre-conditioning incoming ventilation air with return/exhaust air from the building through desiccant wheels can reduce energy requirements for a system. The rotating wheel transfers heat and moisture from the outgoing stream to the incoming stream which significantly reduces capacity and energy needed from the mechanical system.

- *Geothermal Heat Pump*
  Geothermal heat pumps are a great way to harness the consistent energy source from the earth at a temperature in the 50's. A closed-loop setup would be utilized to handle the temperature extremes in this climate by rejecting heat into the earth from the buildings air. This is an extremely expensive and invasive design alternative.
- *VAV System*
  The chilled beam system that Greenspun Hall currently uses is comparable to a typical VAV system. Designers, however, chose to use the chilled beams over VAV boxes due to their greater efficiency. A VAV system would have a lesser first cost but would be less effective.
- *Thermal Storage*
  Storing energy via ice, chilled water, or other solutions could affect energy cost more than energy efficiency. During the summer season, electricity costs spike due to the exponential demand increase. Therefore energy could be stored at night through a large tank and than used during the day, operating on a cyclical pattern. Energy costs are lower at off-peak hours and thermal energy is cheaper than other types of energy.
- *Absorptive Cooling*
  Absorptive cooling utilizes a source of heat (in this case solar) to provide the energy needed to drive the cooling system. These systems commonly use a combination of water and ammonia and the processes of evaporation and condensing to properly reject and absorb heat to meet the cooling load.

Proposed Redesign

The current cooling system for the UNLV Greenspun Hall building, though efficient, is only innovative in the equipment it utilizes, not in the system configuration. The main focus of the proposed redesign will be a more innovative system that harnesses the intense heat of the Las Vegas valley.

To accomplish this, solar-driven $LiBr/H_2O$ absorption chillers will replace the centrifugal chillers currently in use. Fluid will be pumped through direct solar absorbers to a heat exchanger, which transfers energy to the generator in the absorption chillers. Thermally driven chillers will increase energy efficiency and replace the need for electricity to drive them.

In addition to the main redesign, a chilled water storage tank will be added to the load loop connected on a bypass to shift electricity consumption. Overall, the redesign proposed focuses on decreasing operating cost, increasing efficiency, and indoor comfort. Any electricity needed to supply extra power to drive the absorption chillers not provided by the direct solar absorbers will be consumed during off-peak hours to transfer energy to the thermal storage tank. Increasing costs of utilities, mainly electricity, will not have as large of an affect on such a system.

This system would not need more interior space than the current system in use. The mechanical room is large enough for another heat exchanger and the chillers will be swapped out for new ones. Solar absorbers will be located on the roof, which has ample room for equipment. Mainly, the implementation of this new system will affect the electrical system supply power to the cooling system and the operating and construction costs.

Breadth Description

Electrical

Due to the shift and decrease in electricity consumption of the cooling system, feeders to and from the motor control center will be directly affected. Thus, these feeders will be resized. Electricity usage will decrease and be shifted which affects operating cost. Panel sizes will be examined and adjusted where appropriate.

Construction Management

The proposed design allows the unique opportunity to compare economic and energy advantages between systems. A cost analysis will be prepared that takes into account construction cost, including new equipment and labor, and operating cost. It is hypothesized that the proposed redesign will have a greater first cost due to complexity and more equipment, but a lesser operating cost will allow for an agreeable payback period.

Tools and Methods

Initially, a Trace load analysis will occur to size new system components that will be placed into the existing system. Primarily, this is in regards to the absorption chillers, but it will also have influence on the solar absorbers and new heat exchanger selections.

Once the new system is schematically correct and in place, a construction cost analysis will be done which takes into account manufacturing data and data found in R.S. Means. Electricity consumption analysis will determine whether or not the new system is feasible and/or worth while to the owner and the buildings occupants.

Tentative Schedule

The following schedule was prepared to describe the plan to accomplish the mechanical redesign and the corresponding breadth work. My goal for the semester will be to sufficiently meet the requirements of this thesis by staying up to date with the proposed schedule which has some flex time to catch up if needed.

	Week -(January through February)						
Task	1/12-1/16	1/19-1/23	1/26-1/30	2/2-2/6	2/9-2/13	2/16-2/20	2/23-2/27
Research absorption chillers	■	■					
Research solar absorbers and the coordinating heat exchanger(s)	■	■					
Research effectiveness of thermal storage in this application	■	■					
Research Schematics for such a system	■	■					
Schematic System Layout		■	■	■			
Choose system equipment			■	■	■		
Load Analysis						■	■
	Week -(March through April)						
Task	3/2-3/6	3/9-3/13	3/16-3/20	3/23-3/27	3/30-4/3	4/6-4/10	4/13-4/17
Load Analysis (Cont.)	■						
Electrical Breadth			■				
Construction Management Breadth				■			
Organize Information					■		
Prepare Presentation						■	
Presentations							■

January 26: Completion of all major research

Februrary 9: Completion of System Design and Schematic Layout

February 23: All system equipment has been chosen, load analysis is underway

March 16: Completion of Load Analysi

References

1. Vanderweil Engineers, Construction Documents
2. David Miller, Technical Report 1 – ASHRAE Standard 62.1, ASHRAE Standard 90.1 Compliance
3. David Miller, Technical Report 2 – Building and Energy Analysis
4. David Miller, Technical Report 3 – Systems and Existing Conditions Evaluation
5. ASHRAE Handbook of Fundamentals