Mechanical Proposal

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M Resort Spa and Casino

Henderson, Nevada

Tom M. Chirdon

Mechanical Option

Faculty Advisor; William P. Bahnfleth

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1.0 Executive Summary

The purpose of this report is to summarize the information attained in the previous three technical assignments, in an effort to propose a mechanical system redesign for the M Resort. If approved, this proposal will serve as a guideline for research and work throughout the spring semester.

Various alternatives are described in this report, with a final redesign being proposed as well. The focus of the redesign for the M Resort will be a combined heating, cooling and power system. This was chosen due to the high electrical and thermal loads as well as a reduced life cycle cost and overall energy consumption. Due to the scope of work presented, the breadth topics deal mainly with the electrical and structural building systems. Finally, a tentative work schedule has been laid out in order to facilitate the completion of the project for next semester.

2.0 Project Summary

The M Resort, set to be complete in spring of 2009, is a multi use hotel spa and casino located on the southern portion of the Las Vegas strip in Nevada. At a cost of over one billion dollars the building is made up of more than 900,000 square feet. The building consists of two areas; the first is the low rise portion which is approximately 500,000 square feet. This includes a spa, kitchens, ballrooms, meeting rooms, administration, and back of the house as well as a casino level that consists of kitchens, restaurants, and casino space. The high rise portion of the building is comprised of approximately 440 guest suites along with a restaurant atop the guest tower.

3.0 Existing Mechanical System

Low Rise Summary

The low rise portion of the M Resort contains a variety of spaces which include restaurants, spa areas, food preparation, administration, ballrooms, casino space, lobbies and other pertinent areas. The widely variable occupancies of each of the spaces thus lent itself to a variable air volume (VAV) system fed by air handling units on the roof. Smoking control through the spaces is another key priority. Smoking is permitted in the casino spaces and thus the air system must not re-circulate the particulate in the air. One hundred percent outdoor air has been listed as a requirement for the casino and gambling spaces to purge the contaminants out of the air. Smoke control has also been integrated into the control of each air handler in the event of a fire.

Guest Tower Summary

The guest tower will include the guest suites and lofts on floors 2 through 14. These spaces will primarily be occupied during the evening and overnight hours and will require individual temperature control. Each of the guest rooms will be served by a vertical fan coil unit located along the exterior wall of the suite. Outside air will be brought in through integrated wall mullions with the interior space being negatively pressurized through the bathroom exhaust system. Common non-ducted gypsum board exhaust shafts will be used for adjacent suites with an exhaust fan mounted on the roof. Chilled water will be supplied from the central plant and heating will be achieved through an electric resistance coil.

These systems must not only deliver a comfortable climate for the guests, they must also remain reasonably quiet as to not disturb the guests. The units are required to meet a minimum of an NC 30 rating. They have also been designed and installed to facilitate maintenance and repair although it is important that the systems are reliable enough that they do not require constant attention.

The guest corridors are conditioned by two constant volume makeup air units mounted on the roof of the tower. The maid and service rooms will be served by fan coil units similar to those used in the guest rooms.

Service Space Summary

The central chilled water plant is designed to serve the guest suite fan coil units, restaurants and low rise spa and casino level air handling units as well as support space fan coil units. It is sized to handle an initial 3900 tons of cooling with a future capacity of 7500 tons.

The central hot water plant is designed to serve the guest tower restaurant, low rise spa and casino level air handling units and support service space fan coil units. In addition it will serve the domestic hot water heat exchangers, kitchen hot water heat exchangers and the pool heat exchanger. This plant is capable of expanding from 46,800 MBH to a future capacity of 70,200 MBH.

4.0 Alternative Design Considerations

Initially several design alternatives were considered which are described below.

Energy Efficiency Compliance

In technical report three a LEED NC analysis was completed on the building, and certification was not achieved. This rating system is an overall building examination which is not directly in the scope of this project. However, the building could be made more energy efficient through the mechanical systems as well as the energy rating of the skin of the building.

Thermal Storage

The electrical summary along with the thermal loads analyzed in technical reports two and three lead to the conclusion that the peak electrical usage needs o be reduced. Thermal storage for the mechanical systems would help to limit the energy usage of the chilled water system during the peak charge period of the day.

Fan Coil Replacement

The guest room tower is comprised of mainly individual fan coil units and make up air units. An alternative could be replacing these with a more centralized system. This alternative was dismissed because the system was chosen due to its efficiency of installation and minimal ductwork.

Combined Heat and Power

The building has large electrical demands and a mechanical system that generates electricity as well as heat to be used for process applications fits well. Absorption cooling could then be used to cool the building with the excess heat from the turbine.

5.0 Proposed Redesign

After considering the alternatives proposed in Section 4.0, a plan for the mechanical redesign was chosen.

Scope of Mechanical redesign

The energy analysis conducted in Technical Report Two shows that the amount of energy required to run both the Casino/Spa area and the Guest suite is significant especially in the summer months when the demand charge is at its highest. All of this power is taken from the grid which depending on the sources of the electricity can have very large emissions. In the building industry today there is a large push towards energy efficiency and environmental design, this redesign is intended to examine both of these principles.

A combined heating, cooling, and power system will be the focus of this redesign. The energy required to heat, cool, light and other wise power the building and its operations will be used to size the gas turbine engines. The turbines work based on a combustion process in which the exhaust gas flow drives a turbine in turn generating electricity. The waste heat can then be used for varying building processes. Depending upon whether the turbines are sized based on thermal loads, electrical peak or base, it will determine if electricity will still need to be bought from the grid. Regardless a connection will still be in place in case of an emergency as well as o have the ability to sell it back to the utility.

The M Resort is located in Las Vegas and consequently a large need for process heat does not exist throughout the year. Other alternative uses for the large amount of exhaust gas heat must be considered.

The most obvious use for some of the waste heat would be for domestic water heating, kitchen hot water heating, process hot water heating and steam heating. This however will not require use of the full exhaust gas flow. With the large cooling loads, absorption cooling would be ideal for using the exhaust heat. In absorption cooling two different fluids, a refrigerant and an absorbent are used in a thermo chemical process that transfers heat from one place to another resulting in the cooling of some fluids.

Absorption chillers are of two main types, ammonia water and lithium bromide. Lithium bromide water systems are generally for larger tonnages in process systems; however they require condenser water cooling which is usually from a cooling tower. Ammonia water systems are generally for lower tonnage systems and can achieve much lower temperatures down to about -40F and are usually air cooled. If ammonia is to be considered, the toxicity of the ammonia must be included in the redesign.

With Lake Meade's level dropping the water supply to Las Vegas may soon become costly; therefore it will be essential to research the applicability of ammonia water systems for this application.

There are also single effect and double effect absorption chillers. Double effect chillers recycle some of the internal heat to provide part of the energy required creating the high pressure refrigerant vapor in the generator, the single effect do not.

Justification of Mechanical Redesign

This new system will replace the existing chiller, boiler, and most likely the electrical rooms located in the northwest corner of the low rise building. The new system will most likely be better suited to be located on the outside perimeter of the building which will be further discussed in the breadth section of this proposal.

This redesign will focus on reducing the impact on the environment though emissions as well as reducing the life cycle and operational costs. Although it is uncertain whether these objectives will be met, the educational value of this redesign makes it a worthwhile endeavor, especially considering the direction of the building industry.

Integration and Coordination

As the redesign comes together it is important to determine how it will be implemented into the current building design. Combined heat and power (CHP) systems do not run quietly, and currently the mechanical systems are located within the building. For this to work properly it seems that the new system would be ideally located outside of the building as stated above. Therefore the electrical, structural and general building enclosure would need to be modified which is described in Section 6.0 of this proposal.

6.0 Breadth Work

The redesign of the current mechanical system will directly affect other aspects of the building's composition. These changes in the building systems must be reevaluated in order to ensure that they meet code and design intent.

Electrical

Most immediately the electrical system will be altered. The current system draws power from the grid while the redesign generates power internally. Various means of switches and connections to the grid will have to be researched and implemented. Also new load for the proposed mechanical equipment will have to be calculated and incorporated. If the mechanical rooms are relocated, the electrical supply will also have to be rerun. With the changing of the electrical loads the feeders, panel loads, over current protection devices, and main distribution lines would have to be checked and resized.

Structural

The mechanical room is currently located within the building; upon relocating it to the exterior perimeter of the building the internal structure can be altered. This will result in more prime space being allotted for the resort. Currently the structural system is supporting equipment on the roof above the mechanical room, with out this load the structural system would be redesigned to allow for differently loaded beams to be installed. Also a new structure would need to be constructed for the proposed mechanical redesign that would be able to carry the weight of the new equipment.

Construction Management

Electricity will be generated within the building in the redesign. Therefore it would be of interest to analyze the costs of the new system in regards to the lifecycle and overall building cost along with operational costs. The construction schedule would have to allow for the timely delivery and installation of the CHP systems so that electricity can be supplied to the building process.

7.0 Project Methods

The initial focus of the next phase of this project will be to analyze the Trane Trace 700 models to determine the thermal and electrical loads and their profiles that will be used for the sizing of the generating equipment and subsequently the absorption cooling equipment.

Once the new equipment is selected it will have to be placed into the M resort plans. If located on the exterior of the building or remotely, a new facility will need to be designed. This will include making all electrical connections as well as structural alterations to the current and proposed design.

Ret Screen as well as Oak Ridge National Laboratory each has developed software meant to help assess a building for a combined heat and power plant. Research will be conducted on these new programs and if viable they may be used in design.

Costs of the new equipment will be taken from manufactures when available; otherwise R.S. Means will be used to estimate their costs when needed. This will allow for the cost feasibility to be considered in the overall design.

Energy cost is one of the driving factors for the combined heat and power system. The redesigned system will be compared to the current system in terms of annual energy use, emissions, as well as water use. The first cost of the CHP system will also be compared to the current system first cost.

8.0 Preliminary Research

The following is a list of preliminary research that has been conducted in order to make the conclusions and proposals as sated above, more sources will be added to this list as necessary.

Combined Heating, Cooling & Power Handbook: Technologies and Applications. Pletchers, Neil. Marcel Dekker Inc., New York, NY 2003.

CoolTools Chilled Water Plant Design and Specification Guide. Pacific Gas and Electric Company, San Francisco, CA 2000.

ASHRAE Handbook, HVAC Systems and Equipment. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta, GA 2004.

ASHRAE Handbook, Fundamentals. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta, GA 2005.

ASHRAE Handbook, HVAC Applications. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta, GA 2007.

9.0 Tentative Work Schedule

One of the main goals of the spring semester will be to stay ahead of schedule. This will consequently allow me enough time to complete the mechanical redesign as well as all of the breadth work necessary. The beginning of the semester will focus of the mechanical redesign and subsequently move to the breadths as they are enveloped. Table 1 is a tentative schedule for project work; however this is not absolute and can change at any time.

Week -(January through February)							
Task	1/12- 1/16	1/19- 1/23	1/26- 1/30 *1/26*	2/2- 2/6	2/9- 2/13 *2/9*	2/16- 2/20	2/23- 2/27 *2/23*
Verify initial information							
Research Turbine engines and absorption coolers							
Continue research and begin debugging Trace model							
Reconstruct and debug Trace model							
Run model and analyze results in terms of proposal							
Size turbine system and absorber systems							
Combine systems and work out problems							
Review system and begin breadth work							
Spring Break - Flex time (catch up, work ahead, unexpected issues, etc…)							
Electrical Breadth Work/ Finish up mechanical redesign							
Construction Management Breadth Work/ Finish up mechanical redesign							
Finish Breadth Work							
Tie up Loose ends and Prepare Presentation							
Presentations							
* * - Notates Milestone Dates listed on attached sheet		Indicates Future Task			Indicates Completed Task		

Week -(March through April)							
Task	3/2-3/6	3/9-3/13	3/16-3/20 *3/16*	3/23-3/27	3/30-4/3	4/6-4/10	4/13-4/17
Verify initial information							
Research Turbine engines and absorption coolers							
Continue research and begin debugging Trace model							
Reconstruct and debug Trace model							
Run model and analyze results in terms of proposal							
Size turbine system and absorber systems							
Combine systems and work out problems							
Review system and begin breadth work							
Spring Break - Flex time (catch up, work ahead, unexpected issues, etc…)							
Electrical Breadth Work/ Finish up mechanical redesign							
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Finish Breadth Work							
Tie up Loose ends and Prepare Presentation							
Presentations							
* * - Notates Milestone Dates listed on attached sheet		Indicates Future Task			Indicates Completed Task		

Thesis Progress Milestones

January 26, 2009 – Base Research complete turbine and absorber types chosen

February 9, 2009 – Trace Model complete and run properly with sensible results

February 23, 2009 – Equipment sizes determined and final manufacturers chosen

March 16, 2009 – Combined heat and power system determined and compatible, main mechanical redesign complete.

10.0 References

1. ASHRAE Handbook of Fundamentals 2005.
2. Trane Trace 700h.
3. Southland Industries, Mechanical Drawings and Specifications.
4. Mike Hallenbeck and Jessica Lucas Ben Johnson, Thesis Consultants, Southland Industries.
5. JBA Consulting Engineers, Electrical Drawings and Specifications.
6. Kimley-Horn and Associates, Civil Drawings and Specifications.
7. Marnell Architecture, Drawings and Specifications.
8. Tom Chirdon Technical Report One.
9. Tom Chirdon Technical Report Two.
10. Tom Chirdon Technical Report Three.
11. The Pennsylvania State University Architectural Engineering Program, Thesis Advisor, Dr. William P. Bahnfleth
12. Past Thesis Technical Reports, e-Studio Archives, 2006-2008