THESIS PROPOSAL

UNIVERSITY RIDGE
AT EAST STROUDSBURG UNIVERSITY
EAST STROUDSBURG, PA

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MECHANICAL OPTION
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Executive Summary

The following report contains proposed alternatives and a final proposed redesign to the mechanical system for University Ridge at East Stroudsburg University. University Ridge is a 140,000 ft^2 apartment complex which is going to be analyzed and redesigned for a semester long thesis project. Preliminary ideas for redesign were thought about during several technical reports which analyzed different aspects of the building. An issue with the building is that there are individual heating and cooling systems for each apartment unit. Therefore, it was thought to centralize these units in one place and supply district services. After investigation in this report, it was determined that a combined heat and power cogeneration system would be the best solution for the above situation.

The combined heat and power system will provide the heating and cooling needed to condition occupied spaces and heat domestic water. Cooling will be accomplished by the use of an absorption chiller using waste heat from power production. The chiller will also be linked to an ice storage system to level loads on the chiller. Heating of hot water will also use this waste heat to heat spaces and domestic water.

This report also contains the justification for the proposed work. Also, it contains the integration and coordination issues associated with the proposed changes. Initial tools and methods which will be used to determine data and results are also briefly discussed. Finally a tentative schedule of tasks and research for next semester is provided.

Existing Mechanical Systems

The following is a list of major system components based on design data from University Ridge at East Stroudsburg. These buildings are each 4 stories and have an overall size of 140,000 ft^2. The primary use of the facility is apartments for student housing. There is also a commons area with lounges, offices and conference rooms. The following is a basic summary of the mechanical systems for these buildings.

University Ridge contains 153 apartment units with a dedicated duct furnace air handling unit for each of the units. These units are purely re-circulatory. Heating capacity is supplied by hot water coils with hot water supplied from the domestic water heaters. Cooling comes from individual condensing units for greater control. The duct furnace air handlers for the commons area are individually gas fired and are cooled in the same was as the apartments.

The water heaters that supply domestic hot water and hot water for the duct furnaces fired by natural gas and are sized according to the National Plumbing Code with adjustments for the HVAC demand. All other water heaters are electrically heated for spaces such as public bathrooms and mechanical rooms.

There are individual exhaust fans for each bathroom in which they are controlled intermittently.

Alternatives Considered

There are a few alternatives that would be available as viable mechanical systems. A few of the following were considered during design but due to financial restraints were not used. Due to these financial restraints, University Ridge offers many different options for a redesign alternative.

An initial redesign possibility would be the use of 4-pipe chiller and boiler system in each building to supply the heating and cooling. A replacement of the airside system would also be required and would be done so with the use of stacked vertical fan coils. The intent of this would be to increase the efficiency and lower the operating cost. However, this type of system ultimately has a higher initial cost than the original system and would be justified by a payback period. A variation of this type of system would be to use centralized boilers and chillers in an existing service building and run hot and chilled water to the buildings and using the same airside system. Furthermore, this system is not the most overall efficient system for a project like this.

A second option would be the utilization of a geothermal grounds source heat pump (GSHP) system. However, the site sits on a ridge where the ground is extremely rocky. Therefore, the drilling of wells for heat exchanging loops would be inefficient and very costly. This option was considered in the original design and because of the previous problem was not used and for the purposes of the redesign will not be used because of its ineffectiveness.

A third option would be the use of a combined heat and power cogeneration system. The use of this type of system has a couple of options available to produce heating, cooling, and electricity. Analysis of turbines, reciprocating engines, and various new fuel cells will be done to determine which of the previous would be the best solution and which one is more efficient to accomplish the required tasks. The potential benefits of the payback period and increased efficiency will also be determined.

Proposed Redesign

After analysis from the previous technical assignments and gaining an intimate knowledge of the project and building systems, the following proposal will take into consideration a redesign of the mechanical system with a cogeneration system.

Scope:

The scope for the redesign for University Ridge at East Stroudsburg will include a study on a combined heat and power (CHP) cogeneration system which will intern provide heating, cooling and electricity to the whole site. The CHP system will be optimized to handle the overall electric load for the entire project. Also, the exhaust heat from the power generation will be used to heat the regeneration fluid that will be used in the absorption chiller that supplies chilled water. This waste heat will also be utilized for the heating, re-heat and domestic hot water supply. Vertical stacked fan coils will replace the existing air handlers in order to supply the required air properties.

Different methods of cogeneration can be used to achieve the goals stated above. The four main types of CHP systems in which I will first analyze are natural gas micro-turbine engines, reciprocating diesel engines, and at least 2 types of fuel cells. These components will be analyzed to see which would be the best selection based on categories such as emissions, efficiency, cost, reliability, and ease of maintenance.

In order to balance the varying loads of the buildings during the cooling season, a chilled water thermal storage system will be used. This storage system will reduce a varying load on the absorption chiller, thus making the chiller run more efficiently without stops and starts.

Furthermore, the varying power density on the buildings should be analyzed as to see how much power the buildings actually require. An excess of generated can ultimately be used by other buildings on the campus or be put back on the grid and sold to the electric company.

In conclusion, the new combined heat and power system will try to be optimized and will have self sustainable energy. CHP will be used to supply the appropriate amount of electricity, hot and chilled water for all of the buildings mechanical systems. Absorption chillers will be used along with chilled water thermal storage to maintain a constant load on the said system. The feasibility of supplying power to other parts of the campus or selling it back to the grid will also be analyzed. Ultimately, the CHP system will replace all the components of the existing mechanical system and will not require an outside power source.

Justification:

The proposed redesign will not greatly affect the existing buildings. An existing pump house will have to be made larger to house the added equipment associated with CHP. There are already trenches in which the domestic cold water and fire protection piping run so these trenches would have to be expanded to accommodate the chilled and hot water pipes. The overall benefits are immense since power is produced and used by the buildings and even sold back to the utility company. Also, the heating and cooling is provided from this generation thus increasing the total efficiency of the fuel being utilized. The proposal stated above would be a very educational experience which can be used for future reference.

Integration and Coordination

As previously stated, the expansion of the pump house and utility trenches would be necessary to accomplish the proposed changes. Also, the vertical fan coils would have to be accommodated for in the existing mechanical closets, which is not a very big change. The domestic hot water supply would have to be modified to a centralized supply source instead of one for individual units.

Breadth Area

Along with the proposed combined heat and power system, an analysis of the use of photo voltaic (PV) cells will be done in order to see how much power is required in order to supply electricity to the buildings. PV cells which resemble and act as shingles will be analyzed as they do not affect the architectural appeal of the buildings and are fairly unrecognizable. The correct positions and appropriate number of units will be determined from the building orientation and angle of the roofs. Also, a battery system will be analyzed in order to determine if it is feasible to supply the required capacity to power the buildings at night or if it should be sold to the grid.

Also, a cost analysis of the proposed changes to the installation of the mechanical system will be analyzed. The cost of time, labor, and material for the changes in the system will be calculated. A time schedule and cost breakdown will be created showing the construction progress of the system.

Project Methods

The methods to achieve the data required for the proper sizing and operation required for the above described systems will require the use of different programs. Trane Trace 700 will be used to determine the required loads for the CHP system. Also, this program will be used to determine electrical and energy use data. Furthermore, manufacturer's data will be used in determining the absorption chiller and fan coils. Also, manufacturer's data will be used in order to correctly size the photo voltaic system. R.S. Means will be used to determine the cost of the CHP system and the schedule for installation.

Proposed Spring Semester Schedule

The following table is a tentative schedule of building analysis and research for the spring semester. These dates scheduled are subject to change.

Week			Tentative Task Schedule
1	14-Jan-07	20-Jan-07	CHP Research
2	21-Jan-07	27-Jan-07	CHP Research
3	28-Jan-07	3-Feb-07	Research on Absorption Chillers
4	4-Feb-07	10-Feb-07	Research on Ice Storage
5	11-Feb-07	17-Feb-07	Load and System Analysis using Trace 700
6	18-Feb-07	24-Feb-07	Integrating Proposed Systems and Running Analysis
7	25-Feb-07	3-Mar-07	Power Supply Analysis
8	4-Mar-07	10-Mar-07	PV Research and Analysis and Construction Analysis
9	11-Mar-07	17-Mar-07	Spring Break
10	18-Mar-07	24-Mar-07	Wrap up research, solve unresolved issues. Work on final report
11	25-Mar-07	31-Mar-07	Write Final Report
12	1-Apr-07	7-Apr-07	Thesis Report due April 5, Work on thesis presentation
13	8-Apr-07	14-Apr-07	Work on thesis presentation
14	15-Apr-07	21-Apr-07	Senior Thesis Presentation week