Thesis Proposal

Mechanical System Redesign

The Gateway at MICA
Baltimore, MD

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Mechanical Option

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Executive Summary

This report includes the existing conditions of The Gateway at MICA as well as proposed redesign considerations. The existing conditions included in this report are an in-depth look at the system as it is designed. Since the building is not yet constructed this is only the designed system, changes may have been made to the system since the design documents were issued.

The proposed redesign of the building includes a ground source heat pump system to replace the chilled water loop. All terminal units on the residential floors will be equipped with electric reheats allowing the two pipe system to act as a four pipe system. The redesign will also include a cogeneration system to produce electricity for the building as well as provide heating for the first two levels of the building.

The breadth work to be completed will be a cost estimate for the new mechanical room that will house all new mechanical equipment. The second part of the breadth work will be a cost comparison between the existing electrical system and a proposed system.

Existing Conditions

The Gateway at MICA is a 10 story building used primarily for student housing. The building is located at the North West corner of the MICA campus and serves as a gateway to the campus. The location of the site is the intersection of two major travel corridors, I-83 running north and south and North Ave. running east and west.

The building will consists of 2 levels of public space, 7 levels of student apartments and the 10th level will consist of the mechanical penthouse. The public space includes a multi-use performance space, café, gallery space, workshop, and several offices.

The air-side system of The Gateway at MICA consists of four, 100% outdoor air economizing, draw thru AHUs. Three of the AHUs are located in the third floor mechanical room while the fourth is in the 10th level penthouse. The three units in the mechanical room service spaces on the first two levels of the building, while the penthouse unit serves the studio space on each floor of the student living level.

AHU-1 serves the public spaces and rooms on level one and two including some parts of the lobby, the café, conference rooms, offices, and other various spaces throughout levels one and two. This unit has a supply max of 14,500 cfm and supply min of 6,000 cfm. The outside air max and min are 14,500 cfm and 2,900 cfm respectively.

AHU-2 serves the multi-purpose performance space including the booth as well as the facilities office. AHU-2 has a supply maximum and minimum of 9,600 cfm and 4,000 cfm respectively. The multi-purpose space is roughly 3,100 ft^2 and located in the center of the building plan. This space is a double height space with a monitoring booth at one of the room on the second level which is also serviced by AHU-2.

AHU-3 provides air for the lobby/pre-function space and the gallery as well. This is the only constant volume AHU in The Gateway at MICA. The gallery is a single height space just inside the main entrance of the building. This space opens to the lobby/pre-function space which is a double height space. The total floor area for these spaces is roughly 3,600 ft^2. The supply maximum and minimum of AHU-3 is 12,000 cfm and 5,000 cfm respectively. The outdoor air maximum is 12,000 cfm and the minimum is 3,200 cfm.

AHU-4 serves the studio spaces on level three through nine. These seven spaces each have an area of 848 ft^2 and are provided for the students to do work without having to leave their living quarters. The maximum supply and outdoor air for this unit is 11,600 cfm while the minimum supply and outdoor air is 7,000 cfm.

All spaces supplied by AHU-1, AHU-2, and AHU-3 are have terminal units equipped with water-side reheat coils to condition the air as per the requirements of that spaces occupants.

All student apartments on level three through nine have operable windows so the only air-side component of the system on these levels is the exhaust fans for the bathrooms. Each room is equipped with its own water source fan coil unit (FCU) to circulate and condition air. The building was originally designed as a four pipe system so each FCU operates independently and can either heat or cool year round, however, due to value engineering it will be constructed as a two-pipe system.

All of the water side equipment is located in the tenth level penthouse. There are two boilers and two air cooled chillers. The two air cooled screw chillers are identical and each provide 200 tons of cooling capacity. The supply water temperature of the chilled water system is 42°F. The chilled water system is regulated by two 380 GPM end suction pumps with a third 380 GPM standby pump. The boilers are also identical and controlled by one control panel. The cast iron boilers are used for heating purposes and each have a minimum output of 1632 MBH and are regulated by two 150 GPM pumps. The supply temperature for the hot water system is 180°F.

Each stairwell is pressurized with outdoor air from a rooftop mounted fan. The stairwell that goes to the ninth level is pressurized with 15000 CFM and is supplied air on odd numbered levels starting with level three. The stairwell serving the tenth level penthouse is pressurized with 16000 CFM and provides air on even numbered floors starting with the second level. These two stairwells have a gravity controlled relief hood at the roof level.

Alternatives Considered

The first alternative considered is to add electric reheat for the FCUs that are in the student apartments. The system was originally designed as a 4-pipe system and was later changed to a 2-pipe system. The electric reheat for each FCU would eliminate the need to fire the boilers for the purpose of heating. This would save money because instead of heating all the water in the system, it is only heated at the FCU when it is needed for heating purposes.

A second alternative considered is using ground source heat pumps. This could also be an alternative for the FCUs. A closed loop system could be used which would save on energy costs because there would be no need to run the chillers.

A combined heat and power system was also considered for this building. A combined heat and power system uses the byproduct of producing power to provide heat for the building as well.

Breadth

For the breadth work there were several issues addressed. It was found in technical report 2 that several LEED points could be obtained just by using different materials or replacing items with more efficient ones. The following list outlines all things considered.

- Use different roofing materials to reduce the heat island effect
- Use different plumbing fixtures to cut back on water use
- Use different luminaires and lamps to reduce light pollution
- Implement plans to: reuse construction waste, monitor air during construction, flush-out the building with outdoor air before occupancy
- Use adhesives & sealants, paints & coatings, and carpets, composite wood & agrifiber products with VOC levels according the table in the LEED manual
- Use storm water for irrigation purposes
- Building envelope improvement (U value of glass)

By doing these things, energy savings could be analyzed and an in depth cost analysis could be performed.

The second breadth item considered would be to redesign the electrical system for all things changed. There would be new equipment in place and this would result in an obvious change in electrical needs.

Depth Work

For the redesign portion the first thing being considered is a ground source heat pump system that will be incorporated into the design of the waterside system. This system will reduce the chiller load and, in turn, reduce energy consumption. There will also be electric reheats added to all FCUs so the system can operate like a four pipe system increasing comfort for the occupants. ASHRAE Handbooks will be used as a guide in designing this system.

The second change will be to incorporate a cogeneration system into the design. This system will produce electricity for the entire building and also provide hot water for use in thermal applications throughout the building. This system should drastically reduce energy consumption and costs.

Breadth Work

The first breadth item will be the design and construction of an additional room in the building to house new equipment. The new room will probably be a sub-basement level room and a program like Costworks will be used to determine the additional cost of the new room. Materials, labor, and construction costs will be analyzed.

For the second breadth item an evaluation between the existing electrical system and a proposed system will be conducted. The existing power distribution system is a central system where the electricity for the building comes from one transformer. A distributed system will have multiple transformers throughout the building. The reason for doing this analysis is that half of the building is already a distributed power system and changing the entire building to this system could reduce initial cost.

References

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