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THESIS PROJECT PROPOSAL: INTRODUCTION TO DESIGN AND DELIVERY ALTERNATIVES

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Executive Summary

This report is a preliminary version of a proposal for altering the design and delivery characteristics of the NEOMED Research and Graduate Education building and Comparative Medical Unit expansion. These changes are intended to illustrate potential benefits to the owner as well as provide educational value. While the project team had to work with real-world limits on time, money, and design options, here we will have a broader choice to exercise other options.

The project is a very technically challenging one, and the design performs very well given the stringent code and programming requirements. However, the application of certain choices that were not available or were not considered have great potential for savings and project improvement. Here, several choices will be examined and applied in an educational capacity to demonstrate their feasibility and practicality.

The core of this proposal is the implementation of a combined heat and power plant where the existing plant is located in the basement of the RGE building. Accompanying this new system will be an effort to consolidate and streamline building systems, alter equipment and construction materials, and implement metering and feedback systems all in an effort to create an efficient, effective, reliable, and independent building infrastructure. Subject breadths include the implementation of a single-prime project delivery in place of the multiple prime delivery used. Also electrical redesign consisting of such things as emergency power changes and more robust controls implementation will be carried out.

Building Overview

The project is comprised of three additions to the NEOMED campus. The main addition is the Research and Graduate Education Center, a four-story 63,000 square foot biomedical research building. The first three floors are fully built out with laboratories, support rooms, and offices, while the top floor is shelled in and will be built out as the research program grows. There is a 6,000 square foot basement to house stand-alone utilities.

The second component is a 14,500 square foot addition to the Comparable Medical Unit, which provides animal care services. Lastly, several existing laboratories in Building D were renovated.

Existing Systems Overview

The project has utilities independent of the campus infrastructure. Contained within the RGE basement are four 3MMBTU natural gas-powered condensing boilers for heating, two 300-ton electric centrifugal chillers for cooling, and three 1000lb/hr. medium pressure vertical steam boilers for humidifiers and laboratory process equipment.

Most air handling units on the project were custom made by Air Enterprises. Two 100% Outdoor Air AHU's, sized at 37,500 CFM each, serve the lab areas to the west in the RGE. Serving the offices on the east is a smaller AHU at 25,000 CFM and 30% outdoor air. A small constant-volume 4,500 CFM air handler is located in the RGE basement to provide ventilation and space conditioning. The CMU expansion has a new 85,000 unit with 100% outdoor air similar to the two serving the RGE labs.

Running water for the project is provided by a new 6-inch water service. Domestic hot water is provided via duplex 250-gallon gas-fired condensing water heaters located in the RGE basement. The building is designed as a single zone with full recirculation back to the water heaters. A separate supply and return branch provides hot water for the lab equipment and is outfitted with local backflow preventers. The plumbing system is equipped with a duplex water booster to assist in serving the upper floors.

The RGE has a new main electrical service with a single-ended normal power switchboard rated at 480V 3000A. A pad-mounted distribution stepdown transformer takes the 480V down to 208/120V. This transformer is rated at 1500 kVA and is three-phase, four-wire. Power is then circuited throughout the building via double-throw branch automatic transfer switches. A 400kW/500kVA diesel emergency generator sits outside to provide power to the 225A emergency branch serving emergency light and power fixtures. The generator also is connected to a 300A circuit legally required for the fire pump, and an optional 800A standby circuit for HVAC components and select lab equipment.

Lighting in the RGE is mostly fluorescent. All lighting fixtures are suspended from the building structure rather than the ceiling system. Sensors and controls are provided to perform daylight dimming in perimeter areas and zero-occupancy shutoff. Existing Telecommunications system in the Comparative Medical Unit are extended to the expansion and the new RGE Building. 120V power sources, obtained from the emergency/standby system, provide power for alarms and access control system.

Proposed Alternatives

Depth analysis: Combined Heat and Power Implementation

After the various analyses performed over the course of the fall semester, the NEOMED Research and Graduate Education and Comparative Medical Unit Expansion has proven to be a prime candidate for the implementation of co-generation, or combined heat and power, utilities. Many qualities of the project are conducive to combined heat and power. The RGE facility already has an independent plant, and has provisions made for future expansion. In addition, power reliability is absolutely essential for both the animal care areas in the CMU and the research functions of the RGE. Having on-site power generation could save energy and provide an extra measure of reliability.

The base of the mechanical alternate system will be a new configuration of the RGE basement plant to provide both the RGE and CMU expansion with heat, chilled water, steam, electric, and compressed air, all generated on-site via natural gas combustion. Ancillary components of the redesign will include a closer examination of vivarium HVAC requirements to see if any equipment can be downsized or eliminated, as well as a general consolidation of building systems coinciding with the implementation of CHP. Also, potential changes to secondary equipment selection and façade choice will be considered in order to maximize effectiveness of a CHP strategy. In an additional move to reinforce long-term benefits, more robust metering and feedback mechanisms will be implemented to construct a continuous feedback loop and apply inverse modeling techniques.

The intended goal of the redesign with a combined heat and power plant will be to prove long-term cost and operation benefits and simplify and consolidate building systems and equipment, all while providing dependable utilities and maintaining a top level of operability.

The other major depth analysis considered was the implementation of chilled beam systems in place of the current VAV system. This idea had some potential, but also had serious complications attached due to the stringent ACH, humidity, and pressure relationships demanded by the project. The use of chilled beams in a vivarium may not even be allowed via code. While they have been successfully utilized in lab applications, there are a litany of precautions to be taken, and normally are only beneficial in labs where the HVAC system is sized largely based on equipment loads and less making up exhaust from fume hoods. While there is some potential for the implementation of chilled beams to result in less energy waste and smaller airside equipment, there is too much risk associated on this particular project. The airside components of the project's mechanical system will remain largely unaltered.

Construction Management Breadth analyses: Alternative Procurement Process

At the time of bidding in 2011, the state of Ohio mandated that all building projects funded with state money were to be awarded as competitive multiple-prime contracts. As a higher education project, the NEOMED RGE + CMU fell under this ruling and was multiple prime. Since early 2012, Ohio has changed their stance and now allows single-prime contracting for state funded building. The considered construction management breadth would be to consider the potential benefits of using a single-prime delivery on the project. The project experienced notable over-runs due to weather and contractor delays; creating mock schedules of single-vs-multiple prime delivery and comparing the two could shine light on potential savings of both money and time.

One alternative construction management breadth considered was the implementation of prefabricated core MEP shafts. The procurement option was chosen instead because it appears to have more potential for overall time and money saved. In addition, given the complex nature of the building systems implementing a core philosophy could result in serious and time-consuming architectural layout changes

Electrical Breadth: Controls and Emergency Electric

With the present configuration, there are redundancies in the electrical system as well as the mechanical system that could be eliminated with the implementation of CHP. Many of these redundancies can be contributed to the need for power reliability and emergency systems, such as the emergency diesel generator to the south of the RGE. In addition, a more streamlined and precise controls system for the various power, lighting, and lab equipment could be implemented. Due to the 24/7 operability of the research areas, there is no known routine profile for electric demand. In order to cut back on long-term energy consumption, the facility could benefit from more sensor implementation. It was mentioned that the design team did have provisions for occupancy sensors, some of which were value-engineered out.

Another electrical breadth briefly considered was the potential for daylight harvesting from a different building orientation. This option was not chosen due to the aforementioned electrical redesign's tie-in with the mechanical breadth.

Analysis Tools and Methods

Load and energy simulation software will be used extensively to perform the mechanical depth of the redesign. A Trane Trace 700 model has already been created and will likely be utilized to compare the alternative to as-designed; however, other programs such as Equest, IES and EES will likely be utilized as well.

To execute the construction management breadth, a recreation of the real project schedule will be made as accurately as possible. Then, a mock schedule of construction events will be developed for a single-prime delivery for comparison to the first schedule. By using cost data gathered from RS Means and from existing project estimate documentation, cost information will also be correlated to each respective delivery method. Microsoft Project will likely be the scheduling software of choice, and with excel a tie in with cost will be made.

In addition to program usage, extensive building code and guideline research will be performed. NIH guidelines will be examined pertaining to the CMU vivarium, and ASHRAE Lab design guides as well. Early in the work process, it will be crucial to examine a number of CHP case studies to glean lessons learned and practical wisdom.

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Appendix A:

Spring Work Schedule

