Proposal

Father O'Connell Hall Renovation

The Catholic University of America
Washington, D.C

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Executive Summery

Father O'Connell Hall is a historic building located on the campus of The Catholic University. The mechanical system was redesigned in the summer of 2013 maximize efficiency and occupant comfort while keeping initial capital cost at a minimum. If more initial cost was available it may be possible to increase energy efficiency. One possible system that could achieve this is a combined heat power and cooling system (CHPC). Father O'Connell Hall has a great building profile for a CHPC system due to the majority of exterior spaces and low simultaneous heating and cooling loads. In addition, CHPC can reduce the total electrical load, while avoiding transmission and distributing losses with power coming from a plant. Not only could CHPC system reduce total energy usage, but also could cut total overall emissions.

By investigating a CHPC system it is possible to conduct additional analysis how it would impact the rest of the building. An electrical study will analyze the current emergency power, electrical load, electrical connections, and appropriately size all new wires and conduits. An additional acoustical analysis will be done to evaluate all surrounding walls around air handling units have proper sound transmission loss (STC) to maintain a healthy and comfortable environment for surrounding spaces.

Building Overview

Father O'Connell Hall is a 54,000 SF, 15 million dollar exterior and interior renovation on the campus of The Catholic University of America in Washington, DC. Father O'Connell Hall has three conjoined structures: the four story main building constructed in 1914, the three story east wing constructed in 1958, and the west wing constructed in 1962. The Hall is the third oldest building on campus; the renovation will preserve the historical Catholic culture which The Catholic University of America reflects in our nation's capital. Father O'Connell Hall will be used for administrative/Enrollment services, admissions, financial aid, and a banquet hall which will be used to hold special events. Undergraduate Admissions is important because it generates revenue for the school. The design sells the school while still reflection the rich historical tradition of The Catholic University of America and of the surrounding buildings.

The façade is primarly granite stone with Indiana limstone. The façade is broken up with a series of two story arched windows along the main building of the banquet hall, while the east and west wings use large rectangular on story windows. This closley represents a historic collegiate gothic style.

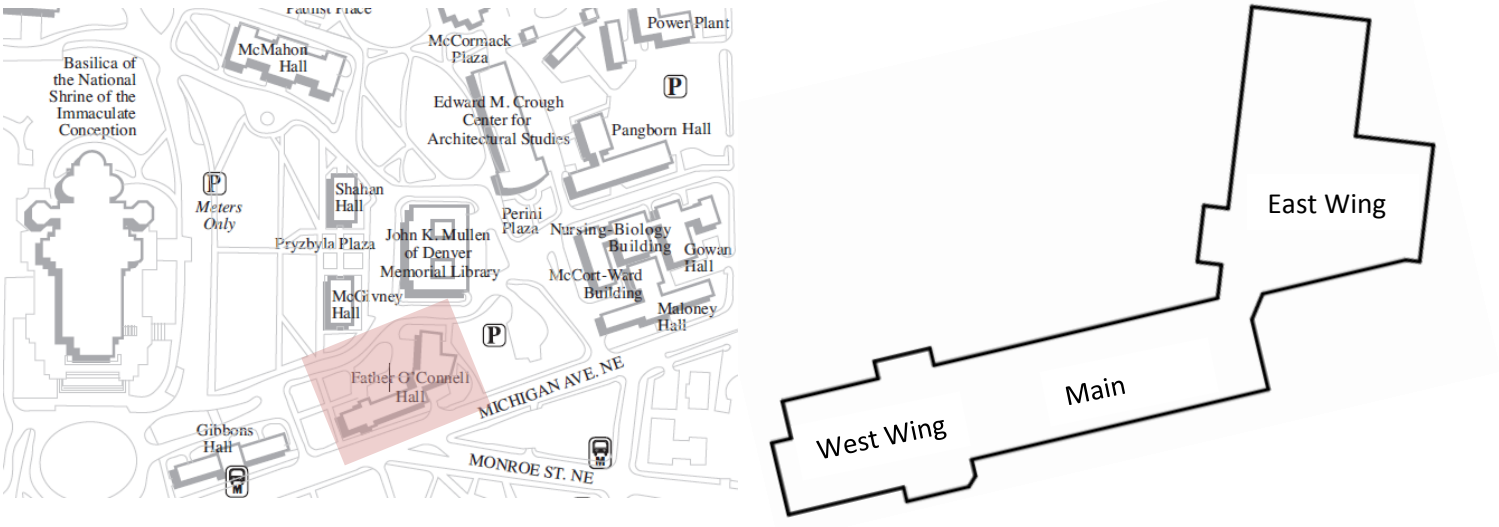

Figure 1: Father O'Connell Hall located on The Catholic University Campus.

Mechanical System Overview

Father O'Connell Hall is ventilated using seven air handling units, with one being 100% outdoor air (OAHU-1). *Figure 1* below shows the zoning for each air handling units throughout the building. All New AHU's will be equipped with economizer cycle to maximize ventilation and reduce energy. The 100% outdoor air unit will also have an air-to-air plate exchanger as well as

a wraparound heat pipe heat recovery exchanger to pre-condition supply air temperatures and further reduce energy consumption. Recirculation of this air is provided by fan powered boxes, VAV's, and air transfer ducts located in the plenum above the ceiling on the basement and first floors.

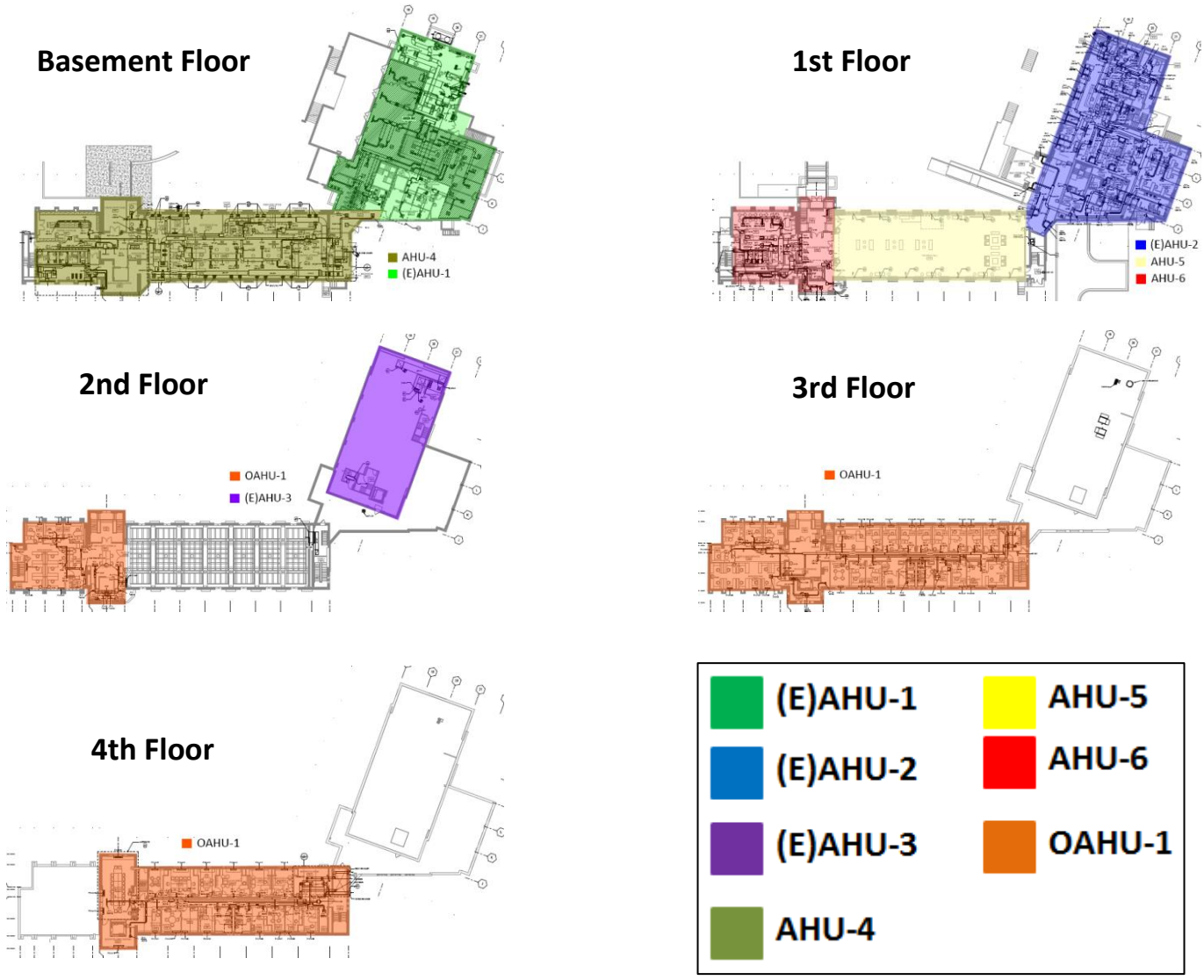

Figure 2: Air Handling Unit Zoning

Chilled Water System

Chilled water is provided from one 97.7 ton electric air-cooled chiller located on grade on the south side of east wing. Chilled water is provided directly to all air handling units (AHU's) and all fan coil units (FCU's) located on floors 2 to 4. Chilled water flow delivered to all AHU's and FCU's is controlled by a proportional integral controller (PIC) control valve regulated by two

chilled water pumps with VFD's. Additional cooling for two telecom rooms is provided by two ductless split system units.

Heating Hot Water System

Washington Gas Company provides a low pressure (2 psi), 2 inch gas pipe to two 500 MBH condensing pulse combustion boilers located on the basement level of the west wing. These boilers provide all hot water to the AHU's, FCU's, and reheat coils for the VAV's and Fan powered boxes. The hot water flow is controlled the same way as the chilled water system using three heat water pumps with VFD's. There are two additional existing boilers located in the east wing of the basement floor. These boilers provide heating to the small portion of the building that is not in the scope of this renovation. Information for this portion of the building is not available at this time.

Mechanical Proposed Redesign

The redesign of the mechanical system for Father O'Connell Hall will focus on reducing energy usage and emissions while increasing productivity through a healthy and comfortable environment for occupants. The proposed redesign is to investigate the addition of a trigeneration system or combined heat power and cooling (CHPC).

Onsite generation can be more efficient and greatly reduce overall air emissions. Approximately 33 percent of the electricity produced by a power plant is usable energy. The leftover 66 percent is lost through production, transmission, and distribution. Furthermore, relying on the grid creates potential brownouts and unexpected service interruptions. By providing onsite generation, unexpected service interruptions can be eliminated by putting the power in the owner's hands. In addition, the current air cooled chiller will be replaced with an absorption chiller. This is ideal for CHPC systems because waste heat from the onsite generation can be used to power the absorption chiller. Air cooled chillers are much more efficient than absorption chillers, but trigeneration systems working together can make this a more efficient system. Absorption chillers eliminate the use of ozone damaging substances by using water as a refrigerant. Furthermore, absorption chillers run off of heat rather than electricity, so electricity demand will be lowered. Trigeneration can be a very high capitol cost with the addition of a turbine and absorption chiller; therefore, a life cycle cost analysis will be investigated.

Father O'Connell Hall could be a great fit for a CHPC system because of the low simultaneous heating and cooling load. The building consists of almost all exterior spaces with low internal loads, suggesting little year round cooling is needed. See Figure 4 below for monthly HVAC energy usages. Therefore, waste heat from the onsite generation can be used for both heating and cooling. Waste heat also provides the opportunity to reduce or eliminate one of the two

condensing boilers that are currently being used to heat the building. See Figure 5 below for a CHPC process diagram. Moreover, Father O'Connell Hall produces over 700,000 pounds of CO2 emissions per year. Emissions could be greatly lessoned with a CHPC system.

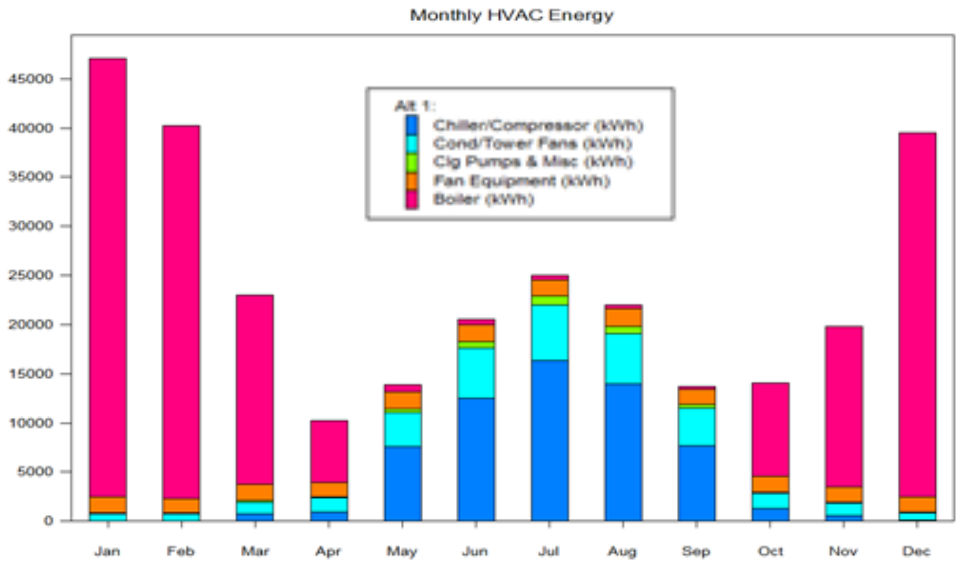

Figure 2: Monthly HVAC energy usage

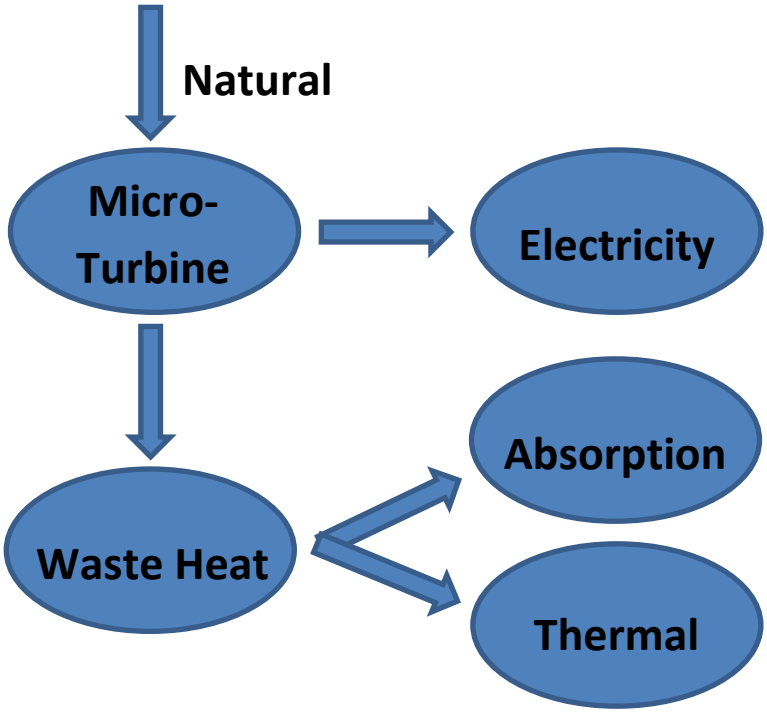

Figure 2: Proposed mechanical redesign combined heating power and cooling

Electrical Breadth

With the addition of a micro turbine, several electrical breadths are available for analysis. An investigation will be done to see how much electrical power can be generated by the CHP system. This cannot be determined until the thermal load is confirmed. An analysis will be done to determined how much of the electrical load can be met. An investigation of emergency power will also be done. The current emergency power has a 150 KW generator that is connected to three emergency panels using automatic transfer switches. An analysis of removing this generator and connecting the micro turbine to emergency power will be done. This could greatly reduce capital cost and allow for a faster payback time. A one line riser diagram will be done to show connections. Furthermore, with the addition of an absorption chiller rather than the current electric air cooled chiller, the electrical load will be reduced significantly. Therefore, investigation to reduce the main switchboard size will be done. All new wire and conduit sizes will also be calculated.

Acoustical Breadth

Father O'Connell Hall is an administrative office building for The Catholic University of America, so acoustical considerations are very important for occupants to be comfortable and productive. An investigation will be done to see if the walls meet proper Sound Transmission Coefficients (STC) between mechanical rooms and occupied spaces, primarily AHU-4 and OAHU-1. AHU-4 is located in the basement mechanical room directly next to and office space. OAHU-1 is located on floor 3 directly adjacent to an executive office. Vibrations also have potential of going into the structure and causing disruptions to the floor below. If the walls do not meet American National Standards Institute (ANSI) STC requirements then recommendations will be made to improve the wall acoustics or reduce the mechanical systems noise, whichever is most cost effective. Dynasonics AIM software will be used to calculate noise from the air handling units and through the ducts.

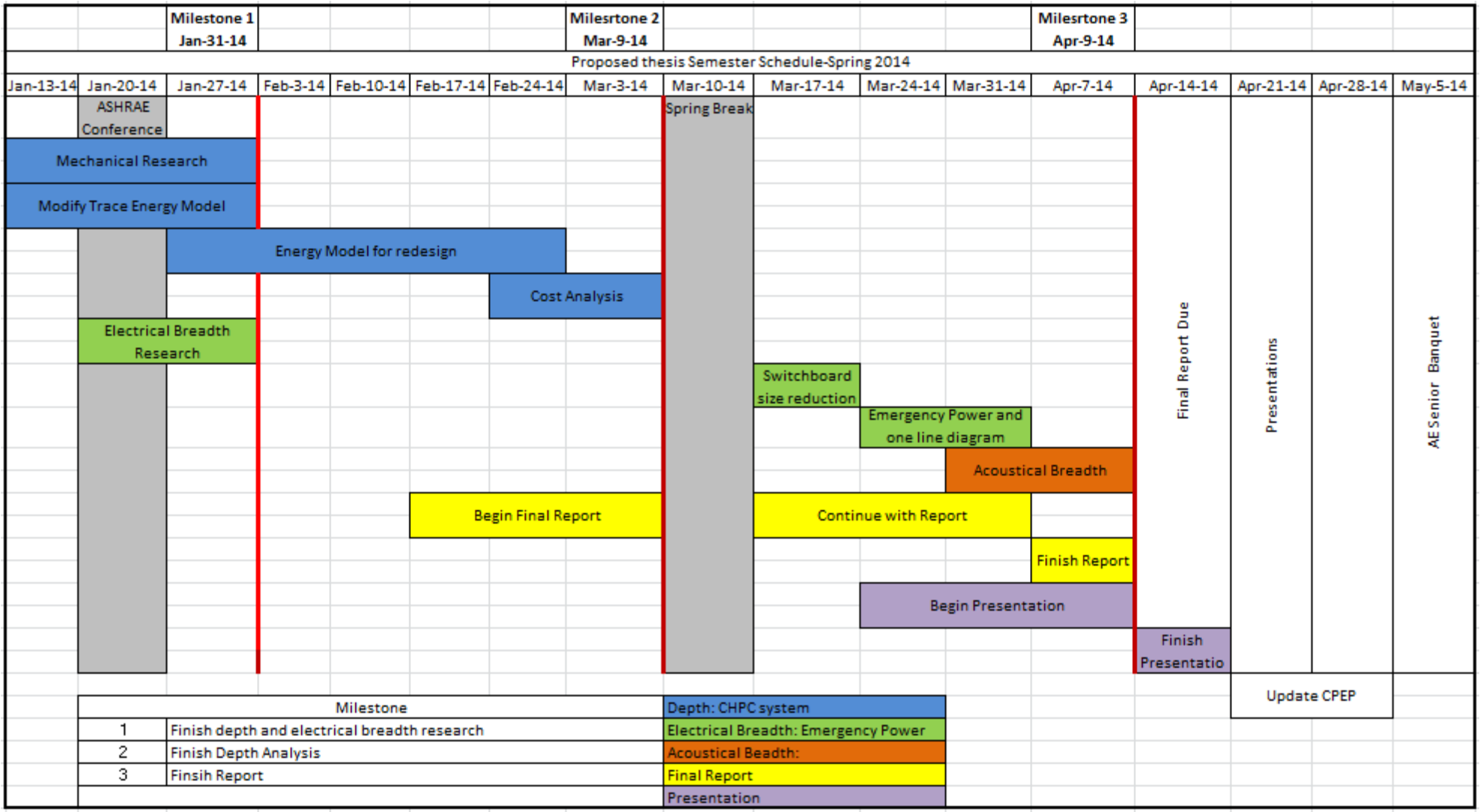

Figure 3: Proposed thesis semester schedule

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