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Broad Institute Expansion: 75 Ames Street

Cambridge, Massachusetts

Mechanical Thesis Proposal

: REVISION I

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Executive Summary

This proposal is for changes to 75 Ames Street, Cambridge Ma. This report contains three proposed changes for current mechanical systems and two breadth changes. The two proposed changes for the mechanical system are for changing offices from a VAV system to active chilled beams, and implementing a return air system for the administration areas. Then for the lab areas an air quality monitoring system shall be added. Chilled beams will cool and heat the load dependent room's t directly and thus only the air required for ventilation will be needed, lowering the supply air needed and wasted energy. The air quality monitoring system also lowers the supply air by only using the ventilation needed due to contaminants in the space, not a pre-assigned schedule. Both the chilled beams and air quality monitoring system will ultimately allow for better use of energy and save on operating costs. These savings will be shown through the energy modeling software TRANE TRACE.

For the first breadth study 75 Ames an electrical analysis for the new mechanical equipment needed shall be studied. The resizing of air handling units and chillers, as well as the new chilled beam system will have a noticeable effect on the electricity of the building and a single line diagram will need to be used to organize the wiring. This breadth will show the new wiring and changes that will need to be implemented to have a properly working mechanical system.

The second breadth studies the structural systems of 75 Ames. Adding, removing, and resizing equipment shall have an effect on the load that the penthouse flooring system needs to account for. And addition or subtraction of weight could have cost implications and this shall be studied for the pent houses of 75 Ames.

Also included in this proposal is a building overview, mechanical system overview, any alternate depth considerations, and a schedule of progress for the spring semester. The schedule of progress has been included to show when activities shall be performed, and important dates to maintain good progress throughout the semester. Activities include both research and analysis for the depths and breadths as well as when writing of reports shall begin.

Building Overview

75 Ames Street is a new 250,000 sq. ft., 15-story high-rise addition to Kendal Square in Cambridge, Massachusetts (figure1 below). This building is designed to bring together the multiple Broad institute offices around the Cambridge area into one location attached to their main office at 7 Cambridge Center.

This structure is set to finish the Ames Street frontage and add to the current pedestrian walk space. This is done with a new pedestrian entrance to a 5-floor garage attached to Ames Street as well as 4000 sq. ft. of retail and restaurant space on the ground floor. The primary design is for offices and research & development labs, which use a majority of the area. Some other notable areas of the 75 Ames are a vivarium on the 12th floor and 3 mechanical rooms making up the penthouse.

The exterior is mainly composed of a mixture of stone, terra cotta, Viracon vision glass and spandrel glass. The penthouse is primarily constructed of aluminum louvers and metal panels. The front façade adds to the vibrant community on Ames Street while the other three facades connect 75 Ames to the current Broad Institute main office next door at 7 Cambridge Center.

Figure 1: A look at the location of 75 Ames Street in Cambridge (courtesy of ELKUS|MANFREDI ARCHITECTS)

Mechanical System Overview

Level M2 hosts the heating plant consisting of two 500 BHP preheat fire tube boilers, four 120 BHP Reheats with one standby, two 215 BHP MPS boilers for humidification and process steam loads, and finally a pressure reducing LPS for humidifiers. Also on M2 is the chiller plant consisting of three 1000-ton chillers for cooling air handing units 1 through 4. Two 450-ton chillers to serve vivarium (AHU-5) and fan coil units, which serve freezer rooms, tell/data, electrical, and the penthouse for spot cooling. Each chiller has a corresponding cooling tower located on the roof.

The ducting on each floor was taken with future floor plan changes in mind. In order to achieve this, air-handling units 1 through 4 each connect to a main ring on each floor. This can be seen in the following figures 2 & 3, which show the supply and exhaust duct respectively. These rings then supply air to each zone on their floor. Since they are serving both labs and offices together return air cannot be utilized since labs call for 100 % outside air. The only return air used in this building is 16000 CFM of air from the connector of 75 Ames Street to 7 Cambridge Center to level M1.

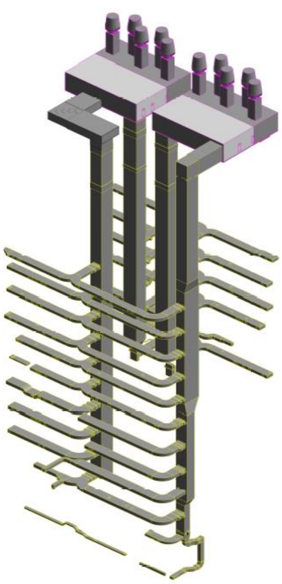


Figure 2

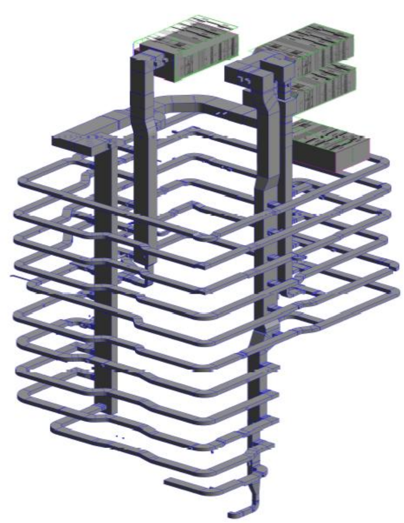


Figure 3

Mechanical System Design Objectives

This section is an in depth report of the mechanical design objectives, requirements and modeled conditions for 75 Ames Street. It will also look into energy usage and costs for these conditions.

Design Objectives

75 Ames's mechanical design objective is to build a state of the art facility incorporating sustainable design principals of energy conservation that will achieve a United States Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) Silver Certification. The HVAC system must be designed and built to support the present building program but maintain flexibility for changes of this program in the future. Spaces to be supported are chemistry wet labs, tissue culture spaces, sequencing spaces, a vivarium on level 12, administration areas, restaurant tenant on level one, and positions of possible future vivarium expansion.

All systems will be designed in accordance with Massachusetts State Building Code, City of Cambridge Ordinances, ASHRAE and other recognized standards, NFPA Standards and good engineering practices. As well an effort shall be put forward to design, layout and place equipment in areas of easy access to encourage routine maintenance. The use of isolation valves shall be implemented to enable easy servicing as well as expansion or renovation of any part of the existing facility without interrupting adjacent areas. Air Handling unit cross connection, ring duct or ganged duct, are used to provide redundancy throughout the facility to ensure environmental comfort to each space with in the building

Alternatives Considered

In preparation for the proposal several different ideas where considered to minimize operating costs and improve the reliability of the system. Below you will find the Ideas considered and a brief explanation of them.

Solar Thermal Heating

A solar thermal system could be placed on the roof of the building to utilize solar energy for hot water heating. This could then lessen the heating bill and carbon footprint of the buildings. One barrier to consider is the amount of heating available depends upon the area available for the collectors and the clearness index of the area. Since 75 Ames is a 250,000 SF building using

348.500 therms of natural gas costing $5.57K annually this could be a potential cost saver, but there does seem to be a lack of space for the collectors.

Rain Water Collection

A rainwater harvesting system could help 75 Ames become a more sustainable building. By collecting rain for use in toilet flushing for example, a great deal of clean water can be saved. There is a roof area of roughly 29,000 SF that could be utilized for rain water collection.

Return Air from offices to be used.

75 Ames was designed for future renovations and it is because of this all areas are 100% outside air and no return air is utilized for any spaces. There is a large potential for energy savings here. In designing two separate systems, one for labs and one for administration, although the mechanical design will not be as flexible, it will be more efficient.

Mechanical Proposal

Supply/Exhaust Redesign: Chilled Beams, Aircuity, and Return Air

75 Ames is a 100% outdoor air building. Because of this there is a lot of energy going into heating and cooling the minimum supply air required for the spaces. By using chilled beams in spaces that are load dependent there is a high potential for savings.

Chilled beams use natural convection in a room to cool air which falls, forcing the warmer air up. If the chilled beams are chosen to heat as well a supplementary heating system may need to be investigated. There are two primary types of chilled beams active and passive. For this project active chilled beams are chosen meaning a pretreated primary air is used to provide ventilation to the room (Seen in figure 4) The first costs of active chilled beams tend to be higher than variable air volume systems, but the operating costs are far lower resulting significant energy savings though lower air handling unit horse power and increased chiller EER. Chilled beams should not be used in any places with ceiling heights of 14’, high latent loads, uncontrolled humidity and restrictions on recirculated air.

An investigation into supplying each non lab area with chilled beams shall be investigated in this depth. Potential savings in cost and energy shall be modeled in Trace.

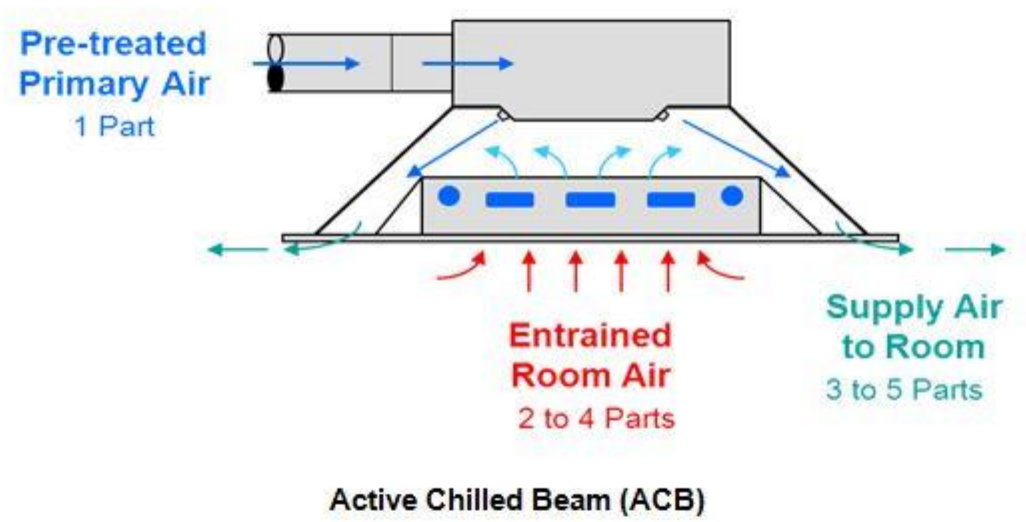


Figure 4

Labs are to be equipped with Aircuity Optinet air sensors which can control the total air changes per hour based on current room conditions and not a preset value. Optinet systems take air samples for a space and by measuring the contaminants in each sample can determine the adequate ventilation rates and can provide an intelligent system for energy efficiency and indoor environment quality.

Lastly offices and non-lab areas will be placed on a new air handler to utilize a return air system for potential energy savings. All spaces due to current design conditions utilize 100% outdoor air to make rooms more flexible for future renovations. A new design for day 1 conditions will allow for some return air to be used to supply office areas separately from the lab areas. This could provide potential savings to the entire building.

The cost of installation and of new or resized equipment shall be investigated. These will be measured against the savings in cost and energy, calculated in Trane Trace, to determine if this system makes sense for the project.

Breadth Topics

Electrical: Lighting/electrical

The mechanical depth proposals for chilled beams and aircuity shall affect the electrical design of 75 Ames in a multitude of ways. For example possible resizing of air handing units and chillers could cause an increase or decrease the amount electricity needed, and a new electrical supply design will need to be designed. The use of chilled beams as well may increase the use of electricity. An electrical analysis will be done to the power needed by the newly designed building compared to the existing and any resizing in electrical equipment that may need to be revised. The electrical breadth will also supply a single line diagram of the how the new equipment shall be fed electricity.

Structural

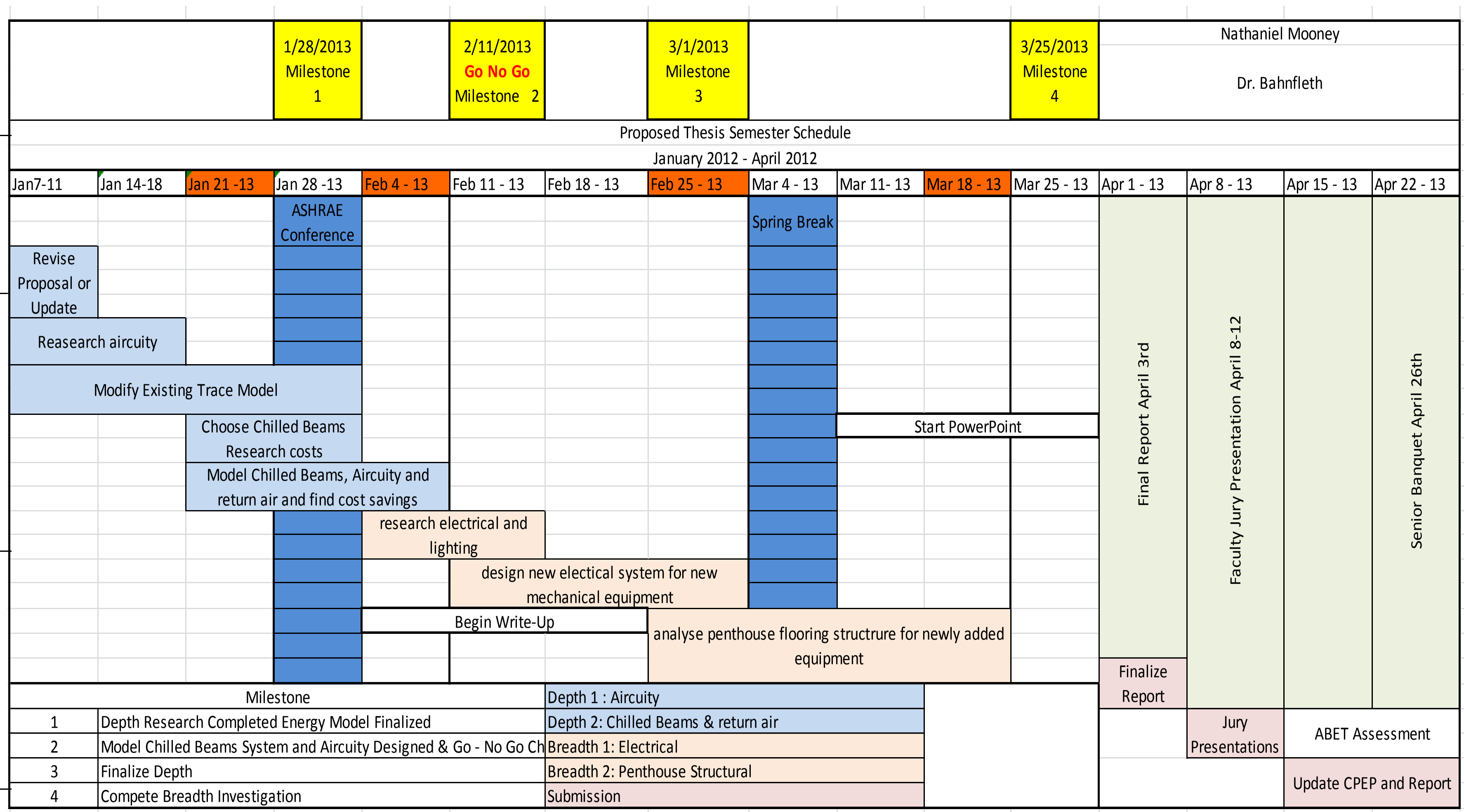
The newly sized and new equipment placed in the penthouse changes the load on the floor. There is a potential for savings if smaller structural elements can be used for a lesser load that may be seen on the new flooring system. An analysis will determine if in fact a new/less expensive floor system can be utilized for the lesser loads. Another structural component is to look at the effect of hanging chilled beams in office area. The added weight may be to heavy for the existing structure.

Project Methods

Three alternate mechanical designs as well as two breadth designs in electrical and structural have been proposed. During the beginning of the spring semester research shall be performed on chilled beams and Aircuity Optinet systems. After the researching a product shall be chosen and effects on air handling unit, chiller, and boilers sizes shall be modeled in Trane Trace, an energy modeling software. New equipment shall be installed if needed and a cost analysis shall be performed for the new additions. This cost shall be compared to the old system to determine payback times and savings.

Aircuity shall be modeled in TRANE TRACE. A typical schedule for labs shall be made using some percentage of the max fume hood exhaust, and minimum fume hood exhaust for times of no occupation. This will give the best-case scenario of savings assuming no spills or accidents occur calling for random high ventilation rates.

Excel and EES may also come into play for organizing information and calculating more complex equations. Construction documents shall supply information for the current lighting and structural systems and calculations for the new flooring and electrical systems may be calculated by hand or excel.


1/28/2013
Milestone
1
2/11/2013
Go No Go
Milestone 2
3/1/2013
Milestone
3
3/25/2013
Milestone
4
Nathaniel Mooney
Dr. Bahnfleth
Proposed Thesis Semester Schedule
January 2012 - April 2012
Jan7-11
Jan 14-18
Jan 21 -13
Jan 28 -13
Feb 4 - 13
Feb 11 - 13
Feb 18 - 13
Feb 25 - 13
Mar 4 - 13
Mar 11- 13
Mar 18 - 13
Mar 25 - 13
Apr 1 - 13
Apr 8 - 13
Apr 15 - 13
Apr 22 - 13
ASHRAE Conference
Spring Break
Revise Proposal or Update
Reasearch aircuity
Modify Existing Trace Model
Start PowerPoint
Choose Chilled Beams Research costs
Model Chilled Beams, Aircuity and return air and find cost savings
research electrical and lighting
design new electical system for new mechanical equipment
Begin Write-Up
analyse penthouse flooring structrure for newly added equipment
Final Report April 3rd
Faculty Jury Presentation April 8-12
Senior Banquet April 26th
Finalize Report
Jury Presentations
ABET Assessment
Update CPEP and Report
Milestone
1 Depth Research Completed Energy Model Finalized
2 Model Chilled Beams System and Aircuity Designed & Go - No Go Ch
3 Finalize Depth
4 Compete Breadth Investigation
Depth 1 : Aircuity
Depth 2: Chilled Beams & return air
Breadth 1: Electrical
Breadth 2: Penthouse Structural
Submission

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