ENVIROCENTER PHASE II

JESSUP, MARYLAND

THESIS PROPOSAL

PROPOSAL FOR SPRING 2012 THESIS PROJECT

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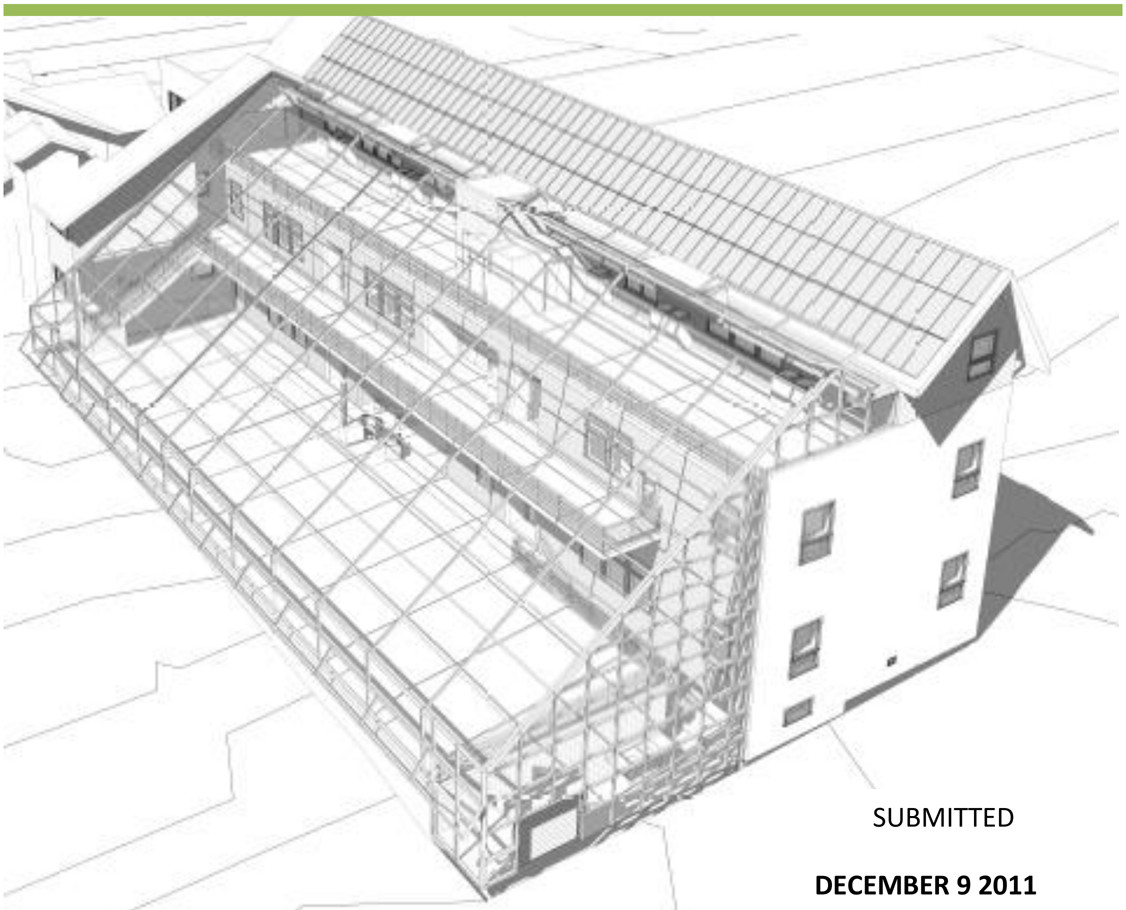

SUBMITTED

DECEMBER 9 2011

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EXECUTIVE SUMMARY

The Envirocenter Phase II is a new 24,000 square foot spec office building to be built in Jessup Maryland. This office building was built with the intent of creating as environmentally friendly an office space as possible targeted toward tenants whose business strive to minimize their environmental impact.

It employs a VAV cooling system, which also provides the necessary ventilation during the heating season. Heat is provided by radiant slabs and walls. Hot and chilled water are provided by two reversible ground source heat pumps.

In this report, I propose changing the ECPII's VAV cooling system with one composed of chilled beams in the ceiling accompanied by floor level displacement ventilation. A means for controlling the humidity in the space will be explored, possibly using solar-recharged desiccants. Another option that was considered was using radiant slab and mass wall cooling, with the existing mixing ventilation system.

Upon selecting the chilled beam option for depth study, two breadth studies arose as a consequence. Firstly, the creation of a ceiling using chilled beams will create architectural elements which will need to be architecturally pleasing. Also, incorporating large displacement ventilation diffusers into the space will require some modifications to the layout, which will also need to make sense architecturally.

Secondly, the changing ceiling will require a new lighting system. With the lights moving closer to the work plane, and moved around to accommodate, the chilled beams, new lighting will be required.

The change to chilled beams with displacement ventilation will be an interesting one to study and will prove to be an excellent educational experience. Not only that, but DV can also provide benefits in terms of both energy consumption and indoor air quality.

EXISTING MECHANICAL SYSTEM DESCRIPTION

DESIGN OBJECTIVES

As with the design of any mechanical systems for any office building, the primary objective of the EPCII's mechanical systems is to provide a comfortable atmosphere so that anyone working there can perform to his/her maximum level of output.

Of course there are a number of secondary objectives that the ECPII's systems intend to meet. One of the design goals of this project is LEED Platinum certification – a lofty goal to say the least. Additionally, the ECPII strives to be as energy efficient as possible, running its systems as close to full load as often as is viable. It is more efficient to operate smaller equipment near full load, than it is to operate oversized equipment at smaller fractions of their full load. This will stretch the capacity of the system and will require the cooperation of the tenants. It is assumed however, that the tenants of the ECPII are companies who wish to minimize their environmental footprints and as such are likely to go along with such measures.

On a related note, the design conditions are as follows. Note that the design set points are less conservative than typical in an effort to lessen the system size.

ASHRAE WEATHER DATA		
SEASON	DESIGN DB	DESIGN WB
WINTER (99.6%)	12.3 F	-
SUMMER (0.4%)	93.6 F	75 F

Table-2 ASHRAE Weather Data

DESIGN CONDITIONS		
SEASON	DESIGN DB	DESIGN RH
HEATING	68 F	-
COOLING	78 F	60%

Table-3 Design set points

EQUIPMENT

The ECPII is served by one air handler, located on the first floor. That air handler supplies 13500 CFM, ranging from 3100 up to the full 13500 CFM of outdoor air. Before reaching the air handler, however, outside air is pretreated as it travels through a bank of earth tubes. It then mixes with the return air in the AHU and is sent back through the earth tubes where it comes out, and hits the cooling coil. It then makes its way to the various terminal VAV boxes, and their associated spaces. During the heating season, the minimum ventilation air is supplied, heating by hot water reheat coils located in the VAV boxes.

Heating is accomplished via radiant slabs and mass walls throughout the building. Additionally, Hot water is supplied by two reversible geothermal heat pumps which transfer heat to the heating hot water via a plate and frame heat exchanger before being pumped to the loads. Chilled water for use during the cooling season is also provided by those heat pumps by the same means. Of course, during the cooling season, chilled water is not supplied to the radiant floors the way the hot water is.

PROPOSED ALTERNATIVE SYSTEMS

RADIANT SLAB COOLING

Instead of radiant slabs and walls for heat, and VAV for cooling, the airside system could be modified to solely provide ventilation air, and the cooling could be done via the same radiant slabs and walls that the heating system uses. One of the obvious problems with this concept is the issue of condensation on chilled surfaces. However, with good humidity control, it is entirely possible.

Part of this concept would be devising a way to maintain the humidity levels. The use of solar-recharged desiccants to treat the ventilation air could be considered. This would be an interesting system to study as radiant cooled slabs are very uncommon.

CHILLED BEAMS WITH DISPLACEMENT VENTILATION

The current means of cooling the spaces in the ECPII is a VAV system, but with radiant heating in slabs and mass walls. Another alternative to this system would be one which uses passive chilled beams in the ceiling to cool the spaces, while providing the necessary ventilation air by means of displacement ventilation. Displacement ventilation has been shown to have benefits for indoor air quality and have possible benefits to energy use. The DV air will still be pretreated with the earth tubes to maximize the amount of free cooling available to the building.

As with the radiant slab idea, care must be taken to avoid condensation on the chilled beams. Although they are generally supplied with slightly warmer cold water, the possibility of condensation is still something which must be considered. Humidity control will be an issue, again likely dealt with by use of desiccants. Dehumidification with a cooling coil would be less desirable because of the added loads to the heat pumps.

Chilled beams and displacement ventilation are interesting systems that I've seen considered on real world projects. In addition to possible IAQ and energy benefits, I feel that working with these systems would be a valuable would be an educational benefit to me.

The use of the chilled beams and displacement ventilation was chosen as the main topic of study.

BREADTH STUDIES

ARCHITECTURE

The ECPII has no drop ceiling, so the chilled beams would be used to create a drop ceiling of sorts. These beams come in a number of sizes and designs, and they could be chosen to create an architecturally pleasing ceiling. Additionally, the displacement ventilation diffusers would need to be near the floor, taking up space. These could be used in an aesthetically pleasing way, such as a free standing floor diffuser being used with a table top, or being incorporated into some sort of decorative column.

LIGHTING

With chilled beams redesigning the layouts of ceilings, the lighting of those spaces will also need to be modified. It will have to agree with the beams aesthetically and also in terms of layout. The fact that they would be hanging lower than before as a result of the chilled beams will also change the requirements for the lights, as they are not closer to the work plane than before.

TOOLS AND METHODS

CHILLED BEAMS AND DISPLACEMENT VENTILATION

First, an accurate model of the building must be produced in order to design and evaluate the effectiveness of these systems. This will be accomplished using a modeling and simulation program like Trane's Trace 700, Carrier's HAP or DOE's Energy Plus. Each tool will be evaluated based on its ability to accommodate the intricacies of this design.

Additionally, the availability of any extra software to aid in sizing equipment will also be explored for the purposes of comparing with the data obtained from the other modeling software.

BREADTH STUDIES

AutoCAD and Revit will be used extensively during this project. A 3-D model is incredibly helpful with both architecture and lighting work. Lighting software like AGI-32 will also be used in order to design the lighting in an appropriate way.

REFERENCES

"Displacement Ventilation Design Guide." ***Price HVAC Design Guide.*** **E. H. Price Limited, 2007.**

A guide produced by HVAC parts manufacturer Price which details what to consider when designing displacement ventilation systems.

Lorenz, Christopher (2011) "Technical Report 2: Building Load and Energy Analysis."

A report which discusses the technical aspects of the Envirocenter Phase II specifically related to its energy consumption.

Loveday, D.L., et al (2002). "Displacement ventilation environments with chilled ceilings: thermal comfort design within the context of the BS EN ISO7730 versus adaptive debate." Energy and Buildings 34 (2002) 573-579

A report which discusses a study that was conducted on chilled ceilings with displacement ventilations and their effectiveness and effects on the comfort of a space.

WORK SCHEDULE