Proposal

Office VRF System with Acoustics and Construction Breadths

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Contents

Executive Summary

Oklahoma University Children's Medical Office Building is a 12-story above grade structure that is part of the Oklahoma University Health Services Division. The building under analysis is located in downtown Oklahoma City, Oklahoma and is situated on the university hospital grounds. The building is primarily comprised of office spaces and patient care services similar to a general medical office building. The medical services provided here are only diagnostic doctor care and outpatient care related to routine check-ups. It is important to note that the construction for the building is based on a tenant fit-out plan and not all of the floors are currently occupied.

The purpose of this report is to give insight into the upcoming building redesign proposal that will take place over the next semester. The proposed redesign incorporates a mechanical depth and two breadths. The depth that was chosen for the Children's Medical Office Building in Oklahoma City is a Variable Refrigerant Flow (VRF) system. The two breadths that are examined will be a construction study involving cost analyses and installations strategies, while the second breadth is an architectural acoustics study examining the efficiency of the floor plan and partitions with regards to sound transmission.

Building Overview

The OU Children's MOB is a 337,000 square foot newly constructed building on the OU hospital grounds. The cost of the project is approximately $60 million, and was set for completion in the spring of 2009. The architecture of the building incorporates a standard brick veneer façade separated visually by large spans of aluminum panels and glass curtain walls to give it a modern appearance. The interior floors are repetitive and feature exterior and interior offices, which are divided by a continuous corridor. Offices and spaces are designated by their corresponding medical use.

Mechanical Systems Overview

The general mechanical layout for the building makes use of an air-handling unit on each of the 11 above-grade floors and 1 basement floor. Each air-handling unit is capable of providing approximately 28 tons of cooling. From the air-handling unit, air is distributed to approximately 40 terminal boxes per floor. All terminal boxes present within the building are intended for variable air volume (VAV). The medical office building uses the plenum space above the rooms for air return and circulation by way of the terminal units and transfer ducts. Additionally, each floor is served by the two mechanical rooms; that which houses the floor's air-handling unit and another at the opposite side of the building were approximately 50% of the distributed air is discharged from the building. All exhaust air travels up to the roof to be relieved.

Chilled and heating water is distributed through the building after transfer in the main mechanical room, which is served by a central steam heating plant and a chiller plant both located offsite, but on the hospital campus. Currently, nine of the twelve floors are in place to be occupied, leaving three floors with AHUs not yet in operation. Furthermore, fan coil units serve the egress spaces on the unoccupied floors, parking deck, and stairwells.

Proposed Alternative

The alternative being proposed herein, a variable refrigerant flow system, serves only as an alternate to the current system and in no way is to represent better or more correct design for the medical office building. The system will be studied as a viable option throughout the semester and evaluated as being a plausible or not option for design.

Depth

The variable refrigerant flow system (sometimes referred to as variable refrigerant volume, VRV) is a system that I found interesting and worthwhile to study when evaluating several options for the Oklahoma University Children's MOB. VRF technology is not a cutting edge system; it has been popular in China, Japan, and parts of Europe for several decades, but until recently it was not popular among the HVAC industry within the United States.

The important factors that caused this system to take precedence for my building are as follows:

- High efficiency
- Increased controllability
- Simultaneous heating and cooling
- Small footprint
- Decrease energy consumption and emissions

It is important to note however that the cause for the small footprint is partially due to less ductwork. Essentially, VRF systems do not need ducting and the only purpose for ducts to be used is for ventilation. Since the building in question is an office building with medical intentions, reducing ductwork must be done carefully and appropriately so as not to induce an unhealthy environment.

Typically, most hospital and healthcare designated buildings have spaces, which require one hundred percent outdoor air. This is to mitigate stagnate air, improve patient comfort levels, and most importantly mitigate the spread of airborne illness. Therefore, in designing the VRF system it is of utmost concern to keep rooms, which are deemed sensitive to stale air connected to a supply of air that is at minimum 30% outdoor air.

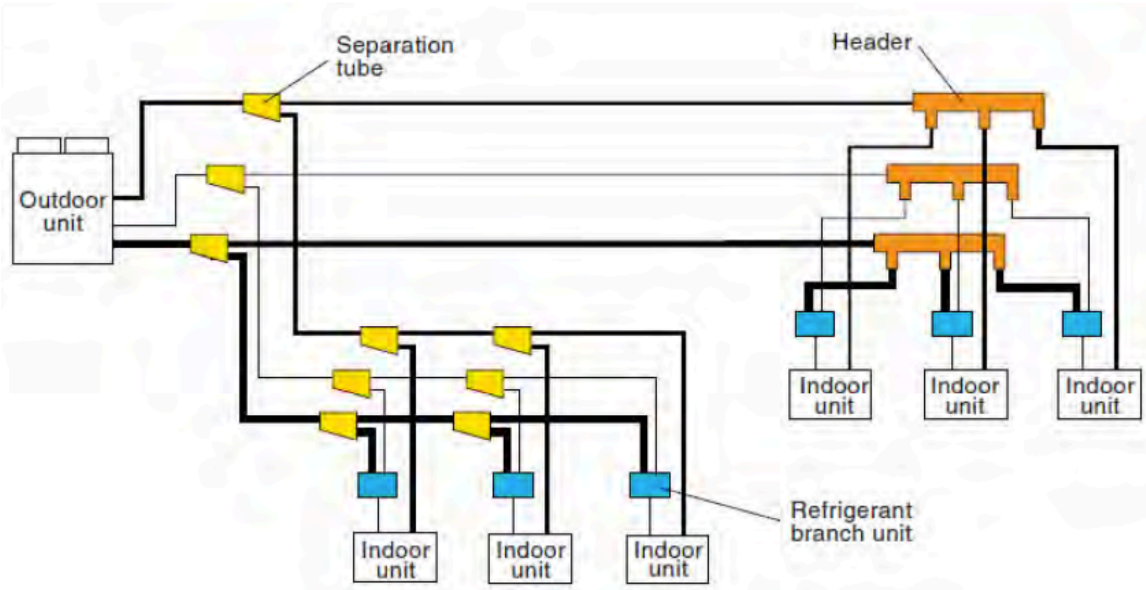

Figure 1: Typical Layout of a VRF System (taken from ASHRAE)

Acoustics Breadth

The changes proposed above to incorporate VRF boxes into each space will greatly reduce the sound created by air handling units in the mechanical spaces and each of the individual occupied spaces. This is mainly due the absence of the originally required VAV boxes, which were designed to serve individual spaces and zones. In addition to inputting a VRF system, a study will be conducted to evaluated the walls between sound sensitive rooms and rooms which require speech privacy and/or low background noise levels.

Spaces will be studied to find which rooms are designed to have high sound pressure levels or are impartial to excessive nearby sound pressure levels, background noise, or speech. If the study results in rooms that do not meet standards for reducing sound transmission than they will be either relocated or the partitions will have to be modified. In this analysis acoustical properties of building materials and mechanical equipment will be evaluated using applicable American National Standards Institute STC standards, basic architectural acoustics calculations, ASHRAE acoustics guidelines, and acoustics software, Dynasonics AIM.

Construction Breadth

With the addition of a VRF systems and reduction of the ducted system, aesthetics, structural capacity, cost, and installation are important factors that need not be neglected. It is assumed at this point in time that the outdoor condensing units will be placed on the rooftop. Currently the design for the medical office building does not seek to have any mechanical equipment located on the roof except for two exhaust fans, thus the roof would provide adequate space for the condensing units if it does not effect the structural integrity. Additionally, mechanical rooms may be able to be reduced due to the small footprint of the system.

With regards to the indoor units, the ceiling and plenum spaces above each room will need to be studied to determine the best method for installing the indoor units if they are to be ceiling recessed while not interfering with the ceiling aesthetics and function. I would like to incorporate all of these factors into a final cost analysis and see how reducing the ducted system and installing the VRF system would compare and it if is cost effective.

Finally, I would like to extend my construction breadth to include strategies that would improve installation. There has been an ongoing stigma with the use of refrigerants affecting the atmosphere and consequently paralleling global warming. In addition, refrigerants are not conducive to human health. I would like to incorporate safe and effective installation methods during construction that would minimize waste, costs, and time, while keeping the refrigerant concealed. Studying the installation methods could prove to be beneficial for the buildings LEED score.

Project Team

- Owner: Oklahoma University Hospital Trust
- Construction Manager: Flintco, Inc.
- Design Architect: Hellmuth, Obata, Kassabaum [HOK]
- Project Architect: Miles Associates
- Structural Engineer: Zahl-Ford, Inc.
- MEP Engineer: ZRDH, P.C.
- Civil Engineer: Smith-Roberts Baldischwiler, Inc.

References

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ASHRAE (2010), Standard 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta, GA, 2009

ASHRAE (2009), 2009 ASHRAE Handbook - Fundamentals. Atlanta, GA: American Society of Heating Refrigeration and Air Conditioning Engineers, Inc.

U.S. Green Building Council. LEED 2009 For New Construction and Major Renovations. Washington D.C., 2008

Appendix A: Semester Work Plan