CareFirst Cumberland

Cumberland, MD

Thesis Proposal

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Mechanical Option

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Executive Summary

This proposal suggest of redesigned mechanical system for the CareFirst Cumberland, MD. In previous technical report, the overall evaluation for the existing building summarized. Within alternative consideration, the existing of mechanical system redesigned into new mechanical system that considered of energy efficiency, construction cost, indoor air quality, and maintainability.

The mechanical redesign proposal will replace the multiple geothermal heat pump units to the single heat recovery unit that can support total building energy consumption. The heat recovery unit contains condenser and evaporator to operate both cooling and heating demands. For the separated ventilation system replaced by the central air handling unit that integrated with the free cooling. With changes of the mechanical system of the CareFirst Cumberland, the electrical and acoustical of the building are impact on it. These topics will be analyzed as breath part of the proposal with change of the depth of the mechanical system. From the ASHRAE Journal, few articles are used as proposal preliminary research. Not only in journal, ASHRAE Handbook of mechanical system and equipment, and other resource are also used.

A draft work plan for spring semester has been created to organize material and allocate design hours of the thesis project. This schedule maintain to work constantly thorough out the semester by each deadline. In the design phase of the thesis, the TRANE 700 modeled to calculate to energy consumption and payback period with comparison of the original design.

Project Background

CareFirst Cumberland relocated in new building for expansion due to lack of office spaces. VOA Architect and Vanderweil, LLC., worked with sustainable energy solution of geothermal water system into the CareFirst Cumberland. With façade of clay brick wall with a strip of stone in a center, the CareFirst Cumberland has simple form of rectangular; each exterior façade faced 4 different directions. Most of the space in the CareFirst Cumberland served as office usage. For second floor of the building, open offices are provided perimeter and core zone. For the employee in CareFirst, exercise rooms and cafeteria is provided in first floor. In center of the building space, lobby and break room areas are used for social events. The north side of 1st building is designed for future use.

Mechanical Summary

The CareFirst Cumberland has geothermal water source system with Dedicated Outdoor Air system (DOAS) primarily support the ventilation of the building. On the building site, 50 geothermal wells connect into the building mechanical system for the heat rejection and heat recovery. Ten of geothermal connect as one branch loop. Three geothermal water loops use for existing building design, and rest of two branches are for future expansion. With rooftop unit, the outdoor air intake provided 9000 CFM into the building, then it will be serve into second floor, and branch ductworks connected into first floor. The duck works arranged in core of the building to have branch duck work with the geothermal heat pump unit in each designed thermal zone. To condition air in the CareFirst Cumberland, 45 geothermal heat pumps those connected into roof top unit duct distribution and geothermal water loop, can recover up to 140, 000 Btu/hr. Geothermal water loop can possibly operate to maintain desired geothermal supply set point temperature of 55F, however, in extreme climate changes, the cooling tower and boiler connected into system for just in case of the geothermal heat reject and recovery are not satisfied. If the geothermal water return temperature within a set point temperature of 3F, return does not necessary circulate all of way back to geothermal well, the heat recovery unit can handle. All of control process operates in energy efficiency with direct digital control of building automatic system. IT Computer laboratory, elevator machine room, few of mechanical and electrical spaces condition with separated air-conditioned unit, because Seven of the electrical heaters used in the tenant expansion space to not to affect interior spaces that are right next to the future space.

Overall Evaluation of system

Overall existing mechanical system of the CareFirst Cumberland is expensive first construction cost and less cost of operation cost since the geothermal water system can have energy for free. Even though the construction cost of the ground source system is expensive and high maintainability, the system is likely used if the operation cost can payback the first cost. The geothermal water system can handle all loads in the building without using boiler; therefore, the system is generally overdesigned. Geothermal wells for future uses still connect into system, so overdesigned mechanical system will operate with full load capacity. To deliver the desired air temperature and quality, the 45 of heat pump units serve in each thermal zone. However, its refrigerant R-410A has highly potential effect on global warming potential, therefore, the maintainability for leakage of the refrigerant needs to be carefully treated. Indoor air quality issue manages with the filter of MERV-8 on both side of outdoor intake and relief air. However, this rating is minimum rate for the office space can filter only up to mold spore, hair spray, fabric protector, and cement dust. That means humidifier dust, lead dust, auto emissions, milled flour, bacteria, tobacco, and smoke cannot be filtered. For the desire air quality of the space, the filtrations of the mechanical needs to be adjust. The table of MERV filtration system provided in Appendix D. Overall mechanical system of the CareFirst Cumberland is fairly effective mechanical system.

Mechanical Proposed Redesign

The original design of the CareFirst Cumberland is decentralized geothermal heat pump systems with separated dedicated outdoor air ventilation system. Individual heat pump units design to cool and heat individual rooms or multiple spaces grouped together by zone. Units are ceiling mounted with duct distribution. With the geothermal source water loop, energy transfer to the distributed ventilation system to supply the conditioned air to the spaces.

The redesign of the mechanical system will focus on improving Indoor air quality, reducing first cost, reducing energy consumption, and centralized maintainability. The proposed redesign is replacing multiple distributed geothermal heat pump units throughout a building to a single unit located in a central mechanical room. The heat recovery chiller that provides heating and cooling can replace the capacity of multiple geothermal heat pumps in a building.

Dedicated outdoor air system is replaced with the central air handlers with the VAV terminals. The existing auxiliary boiler and geothermal water pumps remained in the place to serve the proposed mechanical system. Addition to the centralized geothermal system, the free air cooling applied to the ventilation system in outdoor temperature at or below 55 ^{0}F with no mechanical cooling at all. Above 55 ^{0}F OA, the air may or may not be suitable for use in free cooling, which is depending on its moisture content. Up to 65 ^{0}F OA, the air can be used as free cooling possibly to condition the interior space in a winter.

With the centralized air handling unit, the maintainability can be done easily and more constantly than multiple individual units. Maintenance on air handling unit and filter can improve to the indoor air quality, because the IAQ cause problem from filter, low maintainability, and outside air quality. Even though original mechanical system contained MERV-8 filtration in roof top ventilation unit, not all contaminant air particles can be filtered.

For the construction cost of redesigned mechanical system is not much of difference of the original design, because it is still geothermal water source system, however, the first cost of the equipment cost will decrease, because one or two heat recovery unit replace multiple heat pump units. Operation cost will also decrease with less number of mechanical equipment. The air distribution system is almost same. With change of decentralized to centralized mechanical system required to be have mechanical space, but original mechanical system plan has no extra space for the new heat recovery units. Therefore, the consideration of expand the mechanical space through the building envelopment or through designed office space is required.

Electrical Breath

The proposed mechanical system of the geothermal central system will affect the power distribution system. Replacing multiple distributed geothermal heat pump units to the one or two heat recovery unit will decrease energy consumption. Also, the power source of electrical and natural gas will be compared to which source is more energy efficiency and less emission to environment.

Acoustic Breath

The proposed mechanical system of the geothermal central system replace the multiple distributed geothermal heat pump on top of the ceiling of the office space to the central mechanical space. However, the ventilation distribution and mechanical room acoustically cause problem to the offices nearby. High levels of the background noise effects on personal comfort and work productivity. With modification of the acoustical proof device and analysis, the environment will be modified with complied NC level.

Tools for Analysis

Trane TRACE 700

Both original and redesigned mechanical system will be analyzed and modeled with TRACE 700. This report includes economic and energy performance of the CareFirst Cumberland.

Dynasonics AIM

The Acoustic information Model software is a noise prediction tool to design the model of amount of noise to individual spaces within a building project through the mechanical systems. With noise control accessories, the HVAC noise attenuation substitute into the redesigned air distribution system.

Preliminary Research

Air Quality Filtration

Inghram, David, P.E. "Underfloor for High-Tech Campus." *ASHRAE* Journal (May 2004): 48-50. Print.

Boiler Efficiency

Durkin, Thomas H., P.E. "Boiler System Efficiency." *ASHRAE* Journal (July 2006): 51-57. Print.

Free Air Cooling

"Free Cooling-Outside Air Economizer." *Colorado Springs Utilites*. N.p., 11 Mar. 2005. Web. 16 Dec. 2012.

Geothermal Central System

Durkin, Thomas H., P.E. "Geothermal Central System." *ASHRAE* Journal (August 2007): 42-48. Print.

Geothermal Well Construction Guide

Underground Injection Control Program. "Guidelines For Ground Source Heat Pump Wells." *Massachusetts Department of Enviormental Protection* (January 2012): 1-22. *Http://www.mass.gov/dep/water/laws/gshpguid.pdf*. Web. 16 Dec. 2012.

Trane Centralized Geothermal and Decentralized Geothermal Comparison

Cline, Lee. "Central Geothermal Systems and Control." *Engineers Newsletter Live*. TRANE, Apr. 2010. Web. 16 Dec. 2012.

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ANSI/AHSRAE. (2007). Standard 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Building. Atlanta, GA: American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc.

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"Geothermal Heat Pump Grant Program _Maryland." *Database of State Incentives for Renewable & Efficiency in USA*. U.S. Department of Energy, 2011-2012. Web. 12 Nov. 2012. <http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=MD21F>.

Project Team

- Owner: CFBC Properties, LLC.
- General Contractor: Carl Belt, Inc., http://www.thebeltgroup.com/
- Architects: VOA Associates, Inc.,http://www.voa.com/
- Civil Engineer: SPECS, Consulting Engineers & Surveyors, http://www.specllc.com/
- MEP Engineer: R.G. Vanderweil Engineers, LLP,http://www.vanderweil.com/
- Structural Engineer: Tadjer Coher Edelson Associates, Inc.,http://www.tadjerco.com/