Technical Report 3

FDA Building One – White Oak, MD

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Technical Report 3 provides a clear, concise summary of FDA Building One's Mechanical system, including design requirements, external influences on design, major hardware components, system configuration, control logic, and operating characteristics. In addition, the report considers the merits of the system as a response to the requirements of the building program

Executive Summary:

FDA Building One was renovated on the existing campus of FDA Research Center located in White Oak, MD. The building is being used as the entry focal point for the campus. The building was restored to its historical grandeur while updating the interior mechanical, lighting and structural systems.

The mechanical system that was designed for this building uses a variety of systems to servce the different areas of the building based on the use of the space. FDA Building One receives conditioned supply air from three air handling units (AHU's). The first of the AHU's (OAHU-1) is strictly providing 100% outside air to the peripheral office spaces, the AHU supplying the security pavilion and VAV boxes serviced in part by the third AHU; sized at 5,300 CFM with an energy recovery wheel. The AHU servicing the security pavilion (AHU-2) is provided at constant volume, sized at approximately 7,300 CFM with reheat. The AHU servicing conference rooms and interior areas (AHU-1) through VAV and CAV boxes as well as Dual Duct Air Terminal Units, sized at 19,000 CFM with pre-heat. Two-pipe fan coil units (FCU's) are used in both the electrical closets and telecommunications closets, as well as around the perimeter in private offices.

The total mechanical cost of the system for both design and construction was approximately $6,120,000. If this cost is broken out on a per square foot basis it yields $61.20/sf. The total mechanical portion of the contract represents roughly 17% of the total contract which is within the typical 15%-20% of the construction budget that mechanical systems usually cost.

The building received a Gold Rating from the Leadership in Energy and Environmental Design (LEED) which is a subsidiary of the United States Green Building Council (USGBC). A LEED analysis was performed using the version two rating scale which was the current rating system available. This analysis showed that the design team was focused on delivering a high quality system while making significant strides at reducing energy consumption and improving the indoor environment.

An overall system evaluation was performed and provides critiques of the design system in the areas of construction cost, maintainability, operating cost, and mechanical space requirements. It was concluded that the engineers design was appropriately selected for this project type. Though areas of improvement potentially may not yield large savings in energy or construction costs, there are still design changes that will be investigated during later reports and presentations.

Mechanical System Description and Objectives

FDA Building One was renovated as a part of the FDA Campus Consolidation project being overlooked by GSA at White Oak, MD. An effective Heating, Ventilation, and Air Conditioning (HVAC) system was designed to be installed in the building keeping in mind the existing Central Utility Plant that serves the entire campus. The HVAC system was designed to exceed the minimum system efficiencies stated in ASHRAE Standard 90.1 and the minimum ventilation rates prescribed in ASHRAE Standard 62.1.

Building pressurization and envelope construction quality help to ensure the quality of air within the space by preventing unconditioned air from potentially leaking within the envelope, condensing on building materials, and being a site for mold or bacteria growth.

Possible energy sources that are able to be used at Building One include electricity and steam generated from the Central Utility Plant. The electricity rates that are available to this site are provided by Pepco and the consumption and demand charges are listed below. The rates that are charged to the building is unknown as this information was not released.

	January-May	June-October	November-December
Electric Demand ($/kW)	6.741	8.551	6.741

	January-May	June-December
Electric Consumption On Peak ($/kWh)	0.051	0.053
Electric Consumption Mid Peak ($/kWh)	0.048	0.048
Electric Consumption Off Peak ($/kWh)	0.043	0.043

The outdoor design conditions that were used for this site are listed in Tables 6 and 7 along with the indoor design conditions for each space type. The outdoor design conditions were taken from either the ASHRAE Handbook of Fundamentals or from the weather data that was loaded within the TRACE 700 program. The weather data highlighted are the values that were used during this analysis and provide the most conservative values regarding design loads. The indoor design conditions were estimated from as-built drawings and are listed for both the winter and summer seasons.

	Indoor Design (F)	Outdoor Design (F)	TRACE 700 Default (F)
Summer	75	94.5	93.2
Winter	68	15.9	9.6

An analysis was performed using ASHRAE Standard 62.1 to determine the minimum ventilation rates that need to be supplied to the occupied spaces. The HVAC system that was designed supplies a constant volume of 100% outside air to both buildings. This use of a Dedicated Outdoor Air System (DOAS) ensures that the minimum ventilation rates prescribed by ASHRAE Standard 62.1 will always be exceeded.

A Trane TRACE model was created in order to perform a building energy consumption analysis as well as to determine the design heating and cooling loads. The design engineer performed this analysis using a model that was created on a room by room basis so that the most accurate results could be obtained. A block load model was created for Technical Report Two in order to compare these results to what the design engineer calculated. More information regarding the assumptions and other design input information that was used for the creation of the block load energy model can be found in Technical Report Two.

The Trane TRACE model that was used to determine the design heating and cooling load values was also used to perform a full 8,760 hour energy analysis of the proposed HVAC system. All of the cooling equipment uses electricity to operate while the heating equipment uses purchased steam from the campus steam generation plant. The equipment that was modeled is based upon the data provided within the mechanical equipment schedules from the as-built drawing set. No reliable design documents were provided by the engineer. Other design parameters that were modeled are the use of occupancy, lighting, and equipment schedules which are detailed more within Technical Report Two.

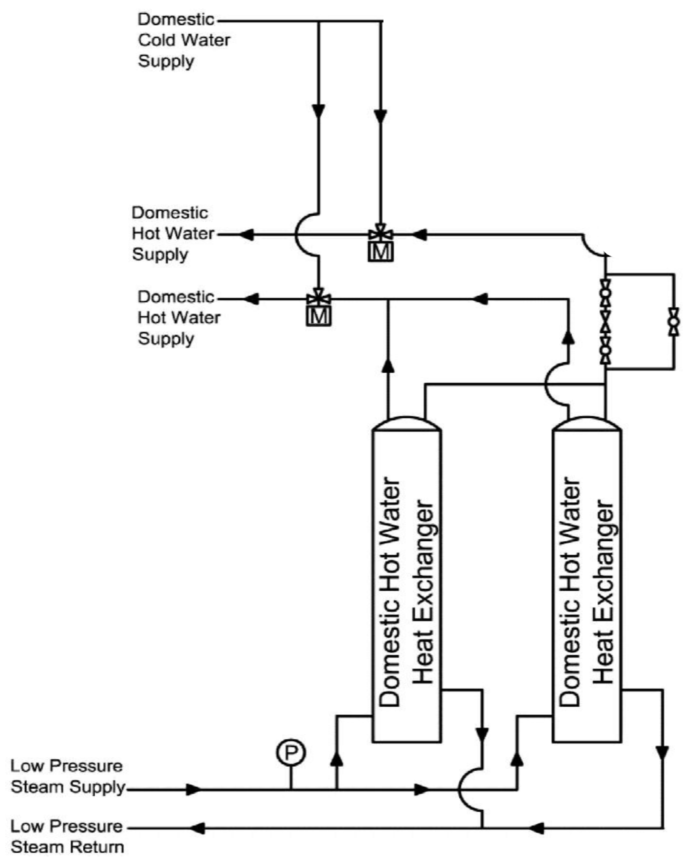
The total mechanical and plumbing system package cost for the renovation was $6,120,000. This system price includes the construction portions due to the project being designed before bidding. When this mechanical system cost is broken down on a per square foot basis it yields a cost of $61.20/sf. This seems to be a very reliable cost for a historical renovation, where not a lot of equipment had to be installed by virtue of the Central Utility Plant.

The total space that was allocated for mechanical system components such as pump, air handlers, duct risers, etc. was calculated by doing take-off calculations from the as-built drawings. Most of the equipment is centrally located within the dedicated mechanical rooms on the first floor and penthouse. In this consideration, penthouse was not taken into account as usable space wasted but the first floor area was considered as such. This resulted in approximately a loss of 9,000 SF of usable space. The space taken up by the VV/CV boxes and distribution ductwork within the ceiling plenums was not taken into account during this takeoff. Actual usable floor areas that are utilized for any mechanical equipment are the areas included within this calculation.

System Operation and Schematics

All of the air handlers in the building have variable speed drives installed on each of their supply fans. The initial start command is sent based upon an occupancy schedule within the energy management control system. The outside air damper will start to open and once it has proven the open condition the supply fan will start. During unoccupied mode the terminal boxes will set back to 30% of the design flow with the air handlers adjusting proportionally based upon the static pressure. An energy recovery wheel is installed on the 100% OA Unit. The heating or cooling mode of operation is determined by the difference in outside air and return air temperature. The enthalpy wheel will slow their rotation if the freeze protection set point is being triggered in order to prevent the coils from freezing.

Aside from domestic water, the waterside operation of the mechanical system is relatively unknown.



LEED® Analysis

The Leadership in Energy and Environmental Design (LEED®) was created by the United States Green Building Council (USGBC) in order to help both building owners and design teams realize the importance of energy efficient and environmentally friendly construction practices.

FDA Building One received a LEED Gold Certification for Major Renovations. The Gold designation is the second-highest level of certification. The property won the designation for having a transportation management plan, utilizing green, off-the-grid power, creating a highly reflective roof and recycling the existing structural frame as well as the brick/limestone veneer.

In evaluation, 49 LEED credit points were earned and it is worth noting that this is the first renovation project in the GSA National Capitol Region to achieve a LEED Gold Certification. As the new home of the US Food and Drug Administration Commissioner, this project represents a commitment to sustainable design principles, including:

-Reduction in the demand for raw materials through the reuse of the existing core and shell and public area finishes, including the restoration of the original brick and limestone exterior.

-Use of low VOC (Volatile Organic Compound) materials throughout the building.

-Replacement of original single pane steel windows with operable, insulated low-E steel units that are interconnected with the building HVAC system.

-Use of a new high SRI (Solar Reflectance Index) roof to mitigate heat islands.

-Use of native plantings and low-water demand plants throughout the project.

-Use of a shuttle bus service from nearby transit hubs and incorporation of preferred and dedicated parking for bicycles, hybrid vehicles, and car / van pools.

Especially noteworthy is that Building One achieved 35.8% energy cost savings below the ASHRAE 90.1 baseline resulting in a maximum ten (10) points available for the LEED category of Optimizing Energy Performance. Contributing strategies include:

-Integrating the HVAC design with the cogeneration central utility plant

-Utilizing natural ventilating, recovering exhaust / relief air energy through an enthalpy wheel

-Insulating the historic building envelope

-Reducing lighting energy through daylight/occupation dimming controls

-Using outdoor air economizers

-Controlling outdoor air quantities through CO_2 demand control ventilation

Overall System Evaluation

The owners wanted to make this a model project for saving energy; hence a few different systems were used for the various areas. Even though indoor air quality may improve with a different system, the energy utilized for this building is pretty efficient with the system in place. Some clever aspects of the design include the coupling of the operable windows with the HVAC system, also the CO2 and occupancy sensors for ventilation and day lighting.

The cost to for installation of the mechanical system is $6,120,000 or roughly $61.20/sf. The mechanical system represents approximately 17% of the buildings entire construction cost. Typically buildings mechanical system costs represent roughly 15%-20% of the total budget so this system falls in the middle of this estimate

The space that the mechanical system occupies is mainly concentrated in the mechanical penthouse located above the connector link as well as space allocated on the first floor of the building. This is not to mention the area of the central utility plant. Potential fan energy savings may be realized once a study is completed for decoupling the centralized fans from the basement to individual floors. This will result in more space being taken up on upper levels but an architectural redesign of a few areas may free up the space required.

The buildings thermal comfort and environmental control are provided by fan coil units to manage thermal comfort while ventilating the spaces with minimum outside air throughout the building. These room zones should not prove to have problems with thermal comfort due to the similar occupancy and load types that were grouped together during zone assignments.

Overall the mechanical system that was designed uses the foundation of a reliable system while adding energy reduction measures to provide an advanced HVAC system for the owner. The mechanical engineer has been able to provide such a system using creative system design and coupling it with an integrated building control system. Making improvements on this system will provide a challenge but areas of potential redesign have risen and will be investigated during future reports.

References:

-ANSI/ASHRAE. (2007). Standard 62.1 - 2007, Ventilation for Acceptable Indoor Air Quality. Atlanta, GA: American Society of Heating Refrigeration and Air Conditioning Engineers, Inc.

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