Mechanical Project Proposal

Defense Information Systems Agency Headquarters Facility

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Mechanical Option

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1.0 Executive Summary

The objective of this report is to summarize the information attained in the previous three technical assignments, in an effort to propose a mechanical system redesign for the DISA Headquarters Facility. If approved, this proposal will serve as a guideline for research and work throughout the spring semester.

Various alternatives were researched, and therefore described in this report. These alternatives were considered and a final redesign was proposed. The focus of the redesign will be on the TE Lab building, which generates 30% of the total cooling load for the DISA HQ. The central cooling plant has been oversized to prepare for future expansion, although it is not definite when and how large the expansion will exactly be.

The redesign will include reducing the size of the central cooling plant, and designing a built-up chiller plant to handle the lab's cooling loads. This built up chiller plant was chosen to allow for modular expansion as the lab space expands rather than building to handle the expansion now, and causing inefficiencies due to oversized equipment. The redesign will also include the installation of water cooled server racks which will combat the huge interior heat gains caused by the lab building's equipment.

The breadth work will result mainly from the addition of this new built-up chiller plant. A new chiller plant will require acoustical, architectural, construction management, and electrical design. A rainwater collection system will also be designed. Finally, an acoustical problem has arose during construction with the rooftop units. This problem will be investigated, and a solution will be found.

Finally, a tentative work schedule has been laid out in order to facilitate the completion of the project for next semester.

2.0 Project Summary

The DISA Headquarters Facility in Fort Meade, MD is set to be complete in February 2011. The facility is a 1,000,070 SF campus which is organized by six integrated buildings; Operations Building, Common Building, Command Building, Acquisitions Building, and the Lab Building. The campus also features a Warehouse and Central Plant.

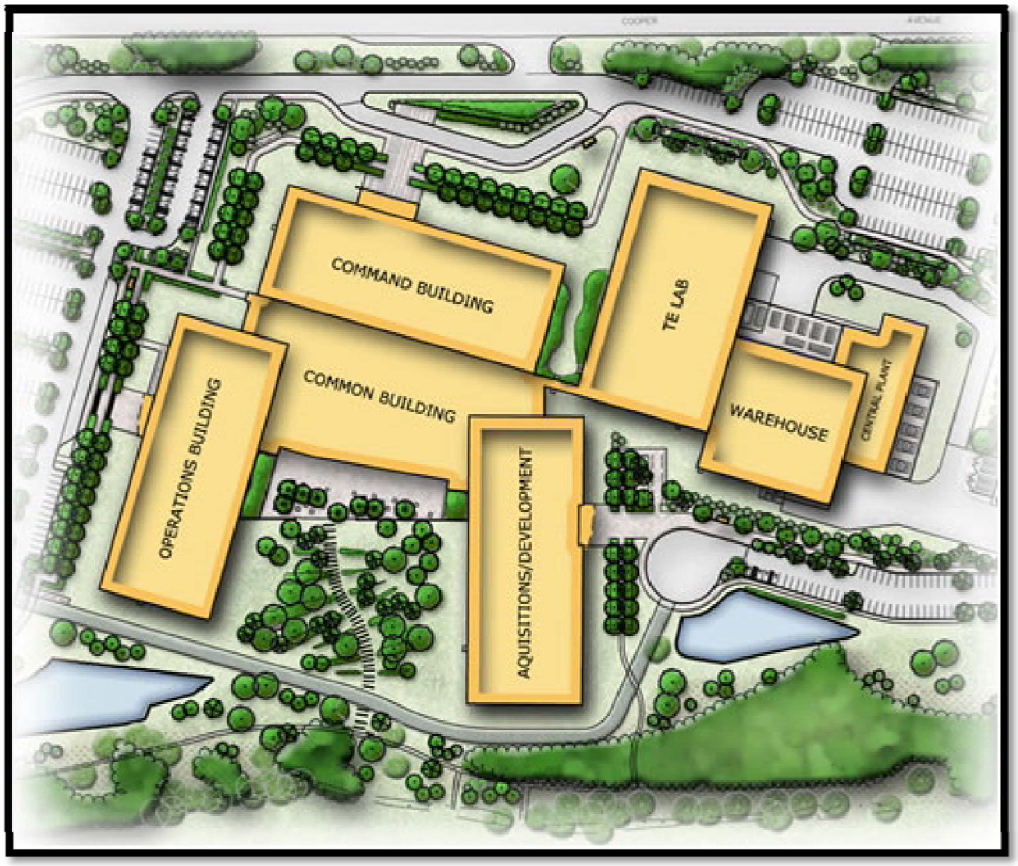

Figure 1- Campus Site Map

At a cost of $380 million, the facility will encompass office space, an electronics lab, a warehouse, cafeteria and dining, a fitness center, a conference area, and central plant.

3.0 Existing Mechanical System Summary

The HVAC system selection for the DISA HQ was driven by the following criteria:

- **The need for flexibility to accommodate future change**
- **The project goal of 30% energy conservation compared to ASHRAE Standard 90.1 – 2004.**
- **Employee Comfort**
- **Best life cycle cost**

The DISA HQ mechanical system first cost was $50,000,000.00, or $46.73/SF.

A Central Utility Plant is attached to the Warehouse building and contains the DISA HQ's Central Heating and Cooling Plants.

The Central Cooling Plant consists of four (4) Centrifugal chillers each with a capacity of 950 tons piped in two (2) pairs of series/counter flow configuration for highest possible chiller efficiency. The chillers will deliver CHW at 42°F, with return water at 60°F, and the plant will meet the entire cooling loads of the facility. Space in the plant will be allocated for a future chiller, pumps, and cooling tower as expansion is expected.

Four (4) Cooling towers will be located in a cooling tower yard adjacent to the plan and will be equipped with fan VDS's and electric sump heaters.

The route of the piping will be through the Warehouse into the Service Corridor, where it will run overhead, with isolation valve branches to each major building along the route. To serve the roof mounted AHU's in the office buildings CHW supply and return risers will be located in the return air shafts to the units. Telecommunications closet CRAC units will be served by separate risers adjacent to the CRAC units. The CRAC units and risers will be in separate enclosures with access from the corridor.

A Heating Plant will be provided adjacent to the Cooling Plant, in a separate enclosed room. The plant consists of four (4) gas fired HW boilers, three (3) of which will handle the entire facility's heating capacity with one (1) as standby. The plant will operate at a maximum HW supply temperature of 200°F and a return water temperature of 160°F with reset capability down to 180ºF supply temperature during mild weather.

General Office Spaces

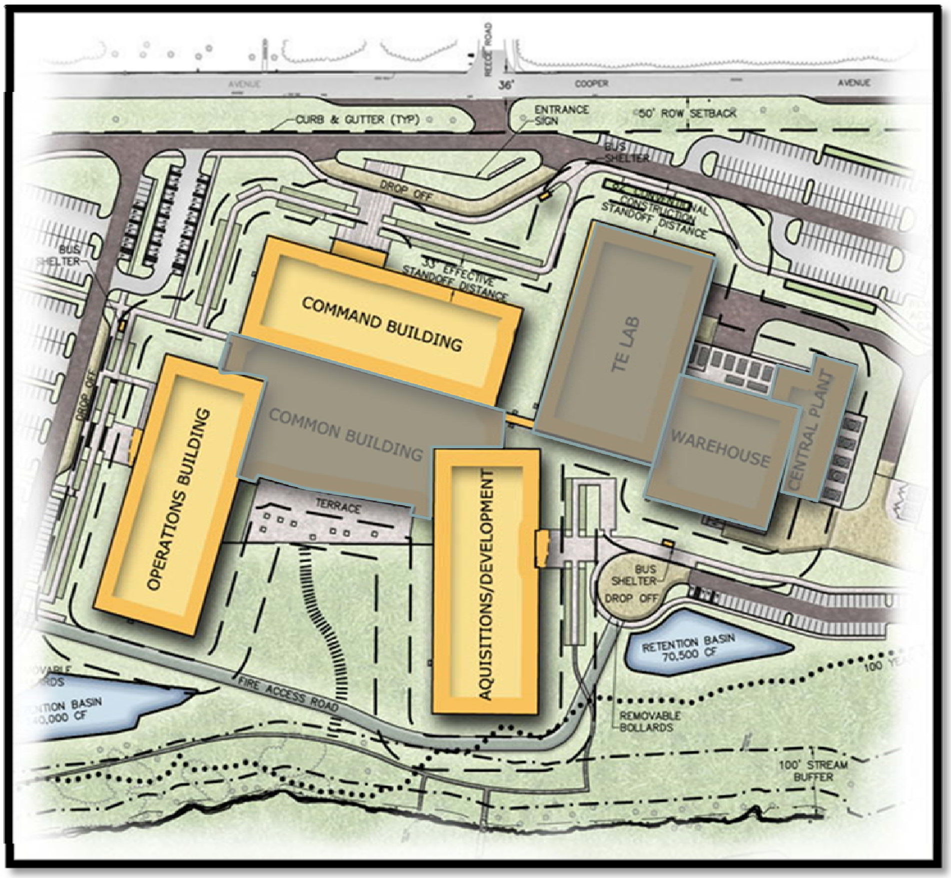

Figure 2- General Office Spaces

An Under Floor Air Distribution (UFAD) system will be provided for all typical office spaces via an 18" raised access floor. The UFAD system will pressurize the under floor plenum using supply air at a temperature between 62°F and 68°F. This UFAD system was implemented due to an increased energy efficiency compared to a conventional overhead system, reduced maintenance costs, increased occupant comfort as well as improved IAQ & ventilation. The ability to save energy while giving each employee ultimate control of their comfort via swirl diffusers along with the potential for LEED points were the driving factors of this decision.

TE LAB

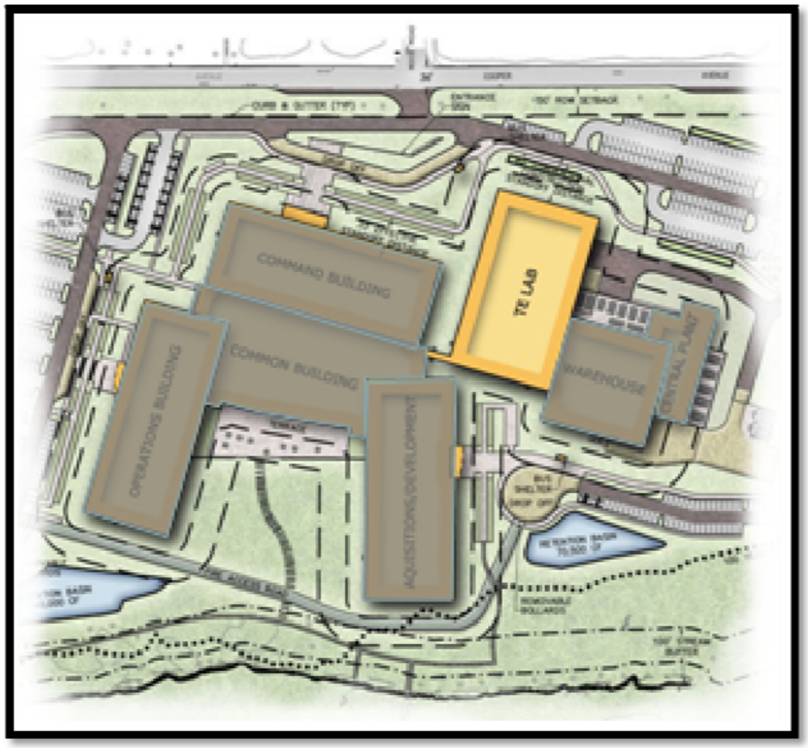

Figure 3- TE LAB

The TE Lab HVAC load requirements are 30% of the total cooling load for the entire facility, so energy efficiency for these systems is extremely important. Vertical air flow, Chilled Water AHU's designed specifically for data centers are coupled with direct injection outdoor air systems to provide both ventilation and humidity control to satisfy the unique demands of a data center with high personnel occupancy. These units will be located in two (2) secure equipment rooms.

This system requires less maintenance, offers great flexibility for lab configurations, and provides greater energy efficiency than provided by traditional Computer Room Air Conditioning (CRAC) units.

Each floor has nine (9) AHU's plus one (1) standby for a total of 20. The supply air is supplied to the TE Lab via perforated floor tiles with manual balancing dampers. Return air will be extracted from the space via RA grilles and into the ceiling plenum until finally reaching the CHW AHU's in the equipment room.

Two (2) 100% OA constant volume AHU's, located in the same equipment rooms as the vertical AHU's distribute air to the TE Lab space and to the individual "hotel" rooms via Constant Air Volume (CAV) terminal units.

The purpose of the CAV terminals is to allow OA quantities to be re-directed to areas of higher occupancy in the future by digital entry at the BAS control console. A system of under floor CHW supply and return piping (sized for future loads of 70 W/SF) was installed as well.

Common Building

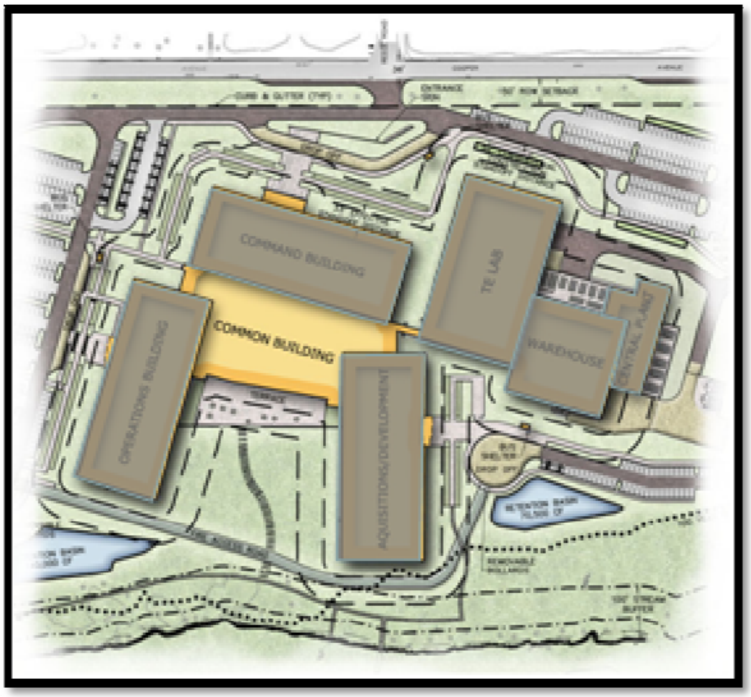

Figure 4- Common Building

The Common Building upper level will be serviced by UFAD via RAF. The lower level will be serviced by overhead VAV systems to accommodate dining, kitchen, fitness and locker room functions.

The Exercise Room will be provided with a separate overhead VAV system that operates in conjunction with the Locker Rooms. A separate roof mounted AHU will serve this area. The system will be similar to that described for the Dining Area. Locker Rooms will be ventilated by roof mounted exhaust fans. Transfer air from the Exercise Room will provide make-up air.

4.0 Alternative Design Consideration

Initially several design alternatives were considered which are described below.

Ice Storage

Ice storage is a method of thermal storage in which a building's chillers run at night during off peak utility rate time periods. This chilled water is frozen in ice storage tanks with coils running through it. Then during the day, chilled water is ran through these coils to be cooled rather than having to run the chillers all day at the premium utility rate cost.

Ice storage was reviewed briefly in the design state, but there was no available real estate in the building to put the tank farm. The programmable area was very tight for the DISA HQ as DISA could only build a given square footage that was locked in. Also the electric rate structure they have from BG&E was not that conducive for storage either.

Overhead Air Distribution in Office

The UFAD system designed by the Mechanical Engineer of record was a major selling point to DISA. DISA liked the idea of each occupant having individual control of their own comfort. Also the UFAD system helped the design team lead this project to be in line to receive a LEED Silver designation. The UFAD system is a good design response to the RFP. Therefore, overhead air distribution will not be considered for the office space.

Critique

The office space in the DISA HQ is fairly straight forward so I will be focusing on the Lab space. The office space's UFAD system works well for the owner and the project. Although this project is in line to receive LEED silver designation, I believe there are changes that can be made to make this project greener.

The main focus on my proposal will be improving efficiency which will result in energy savings. Energy savings will not only translate to lower costs to the owner, but also will help the environment. This to me is what a "green" building should accomplish.

5.0 Proposed Redesign

After completing this semester's technical assignments, I have had the opportunity to learn a lot about the design of the DISA HQ, and the thought process behind the design. I have researched the building's systems, spoken with the design engineer about alternative designs that were originally considered, and finally considered what changes could be made to this project.

The mechanical design changes are being focused on the TE Lab building. This was chosen due to the fact that the lab has extremely high cooling loads (30% of entire facility's cooling load). The lab is expected to expand in the future, and therefore to handle these loads the central cooling plant and distribution piping has been oversized. The oversized equipment has been installed up front, so when the expansion takes place the infrastructure is already there to handle the new loads. This seems inefficient, to spend more money buying larger chillers, pumps, and distribution piping.

Built-Up Chiller Plant

I am proposing the installation of a built up chiller plant to handle the Lab's cooling loads. This built up chiller plant would consists of water cooled condensers and an integral fluid cooler which offers a lot of economizer hours. I think this would help solve the problem of the inefficiency of the oversized cooling plant, which is a waste of upfront costs as well as operating costs.

In this scenario, a separate chiller plant would be built to handle the Lab's cooling. This would lead to a decrease in size and equipment of the main central utility plant. In this plan, the cooling plant could be built now to handle just the current loads, not the future. In the future, when expansion occurs, more chillers can be added to the built up chiller plant to handle these loads. Therefore, you only have the extra capacity when it is needed. This would be helpful due to the fact the expansion is eminent, but the date of expansion is not known.

Water Cooled Server Racks

Experts have grown increasingly worried about how much energy the nation's data centers use. In 2006, the U.S. Environmental Protection Agency estimated that data centers consumed 1.5 percent of the nation's electricity -- more than all the color TVs in the country. And without significant changes, energy use at data centers was expected to double by 2011, according to EPA's report.

The server racks in the lab building create huge interior heating gains. This led to the lab building consuming 30% of the facility's cooling load, while only taking up 10% of the facility's programmable area. Google and

Syracuse University are two examples of recently constructed lab spaces which have utilized water cooled server racks to offset the huge heat gains these pieces of equipment give off.

Syracuse University recently teamed with IBM to construct what is known as one of the most energy efficient computer operations in the world. Syracuse was able to receive over $2 million in public grants for installing such an efficient system. The potential tax credits could help drive down the additional upfront cost of adding these water cooled chiller racks.

I am proposing installing chilled water cooled server racks which would be fed by the new built up chiller plant discussed above. If installed, these could cut down the need for as much cooling as currently designed. If you could combat the heat gain at the source, less warm air would be given off into the room leading to less room cooling needed. This could lead to a reduction in chiller plant size.

Figure 5- Water Cooled Server Rack

The controlled airflow inside a relatively small enclosed space enables the evenly distributed cool air supply for all servers, regardless of their installation position in the rack. The top server is cooled exactly as much as the lowest.

6.0 Breadth Work

Roof Top Units Acoustical Problems

After speaking with the Mechanical project manager on the DISA HQ, I learned that they are currently having acoustical problems with the roof top units. This problem was not found until the units were set, and began running. Therefore, first off I would like to look into a acoustical solution to this problem. This is especially important in office space, as the employees who work on the top floors may be distracted by this unwanted noise. I will look into the construction of the roof, along with the roof top unit details to find a solution to this problem.

Rainwater Collection System

I will also be looking into water collection system on the roof for rainwater. The DISA HQ has an enormous amount of rooftop square footage. This could be used to collect rainwater, and there is ample site space to place a water collection tank. The fact that it will rain is inevitable, you might as well collect it. This will lead to water savings as you could use this collected water for irrigation, or other creative uses. The installation of a rainwater collection system could also possibly add more LEED credits to the project.

I will be designing and sizing the entire rainwater collection system including the tank and main piping. I will also be finding a place to locate the tank in which the owner would not disapprove.

Built-Up Chiller Plant Addition

If the above proposed built-up is installed, there will be acoustical, architectural, and electric problems to be addressed. First of all, I will design a new chiller plant for the lab space. This plant will have to match the architectural theme of the DISA HQ, and be visually pleasing. Also the acoustics of the plant will have to be addressed to ensure the new plant will not be a nuisance to the building's occupants. The new chiller plant will reduce the size of the central utility plant's equipment leading to a decrease in electrical power need to that building. I will resize the electrical equipment feeding the CUP, and also design a new electrical distribution to feed the new chiller plant.

7.0 Project Methods

The initial focus of the next phase of this project will be to analyze the Trane Trace 700 model, and reconstruct it with the proposed changes. I will also use the Trane Acoustic Problem (TAP) to analyze the acoustics problems with the roof top units as well as the new chiller plant. For the architectural design of the new chiller plant, Autodesk Revit and AutoCad will be used.

8.0 Preliminary Research

The following is a list of preliminary research that has been conducted in order to make the conclusions and proposals as stated above, more sources will be added to this list as the project progresses.

ASHRAE Handbook, HVAC Systems and Equipment. American Society of Heating, Refrigeration, and Air Conditioning Engineers, INC., Atlanta, GA 2004.

ASHRAE Handbook, Fundamentals. American Society of Heating, Refrigeration, and Air Conditioning Engineers, INC., Atlanta, GA 2004.

ASHRAE Handbook, Applications. American Society of Heating, Refrigeration, and Air Conditioning Engineers, INC., Atlanta, GA 2004.

9.0 Tentative Work Schedule

One of the main goals of the spring semester will be to stay ahead of schedule. This will consequently allow me enough time to complete the mechanical redesign as well as all of the breadth work necessary. The beginning of the semester will focus on the mechanical redesign and subsequently move to the breadths. The table below summarizes the tentative work schedule; however this is not absolute and will change.

	ℹ	Task Name	Duration	Start	Finish	Predecess
1		Research Topics	34 days	Tue 12/8/09	Fri 1/22/10	
2		Research @ ASHRAE Conference	5 days	Mon 1/25/10	Fri 1/29/10	1
3		Reconstruct Trace Model	7 days	Mon 2/1/10	Tue 2/9/10	2
4		Run Model and Analyze Results in Terms of Proposal	3 days	Wed 2/10/10	Fri 2/12/10	3
5		Size New Systems/ Design	7 days	Mon 2/15/10	Tue 2/23/10	4
6		Review System/ Begin Breadth	7 days	Wed 2/24/10	Thu 3/4/10	5
7		Spring Break (Relax/Catch Up/Work Out Issues)	10 days	Fri 3/5/10	Thu 3/18/10	6
8		Work On Breadth/Finish Mechanical	5 days	Fri 3/19/10	Thu 3/25/10	7
9		Finish Breadth	10 days	Fri 3/26/10	Thu 4/8/10	8
10		Finish Presentation	3 days	Fri 4/9/10	Tue 4/13/10	9
11		Presentations	6 days	Wed 4/14/10	Wed 4/21/10	10