



### DISA HEADQUARTERS FACILITY



**GEORGE BLAVIK III**  
FACULTY ADVISOR, DR. STEPHEN TRELOAR



"DISA, a Combat Support Agency, engineers and provides command and control capabilities and enterprise infrastructure to continuously operate and assure a global net-centric enterprise in direct support to joint warfighters. National level leaders and other mission and coalition partners across the full spectrum of operations."



*"In Religion, The Strongest Beauty Is of"*

### PRESENTATION OUTLINE

- PROJECT BACKGROUND
- EXISTING MECHANICAL SUMMARY
- DESIGN OBJECTIVES
- ALTERNATIVE DESCRIPTIONS
- WATER COOLED SOLUTION
- ENERGY ANALYSIS & PAYBACK
- REFRESHMENT COOLED SOLUTION
- ENERGY ANALYSIS & PAYBACK
- SUSTAINABILITY BREADTH
- FINAL RECOMMENDATIONS




### PROJECT BACKGROUND

DEFENSE INFORMATION SYSTEMS AGENCY (DISA) HEADQUARTERS FACILITY

LOCATION AND SITE: FORT GEORGE G MEADE, MD  
 DATES OF CONSTRUCTION: 1/1/09-2/1/11  
 OWNER: DISA  
 SIZE: 1,070,000 SF  
 PROJECT DELIVERY METHOD: DESIGN-BUILD

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### PROJECT BACKGROUND

THE CAMPUS HAS SIX INTEGRATED BUILDINGS:

- OPERATIONS BUILDING
- COMMON BUILDING
- COMMAND BUILDING
- ACQUISITIONS BUILDING
- LAB BUILDING
- WAREHOUSE/ CENTRAL UTILITY PLANT

THE PROGRAM CONTAINS:

- 70% OFFICE SPACE (OPERATIONS, COMMAND, ACQUISITIONS BUILDINGS)
- 7% LAB SPACE (TE LAB)
- 1.0% COMMON SPACE (COMMON BUILDING)

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### EXISTING MECHANICAL SUMMARY

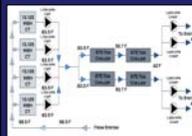
CENTRAL UTILITY PLANT  
 Heating Plant (Red), Cooling Plant (Blue)

MAIN STREET SERVICE CORRIDOR

- 2 STORY CIRCULATION CONNECTING ALL BUILDINGS
- DOUBLE AS MAIN CIRCULATION SPIKE ON TOP LEVEL FOR ALL OCCUPANTS & SERVICE CORRIDOR ON LEVEL BELOW
- ALL CHW/WH DISTRIBUTION FROM THE CUP RUNS THROUGH THIS CORRIDOR AND FEED OTHER BUILDINGS

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### EXISTING MECHANICAL SUMMARY

CENTRAL COOLING PLANT

FOUR CENTRIFUGAL CHILLERS - REFRESHMENT R-134A

CAPACITY - 2,974 TONS @ 82% TONNAGE = 2600 TONNAGE

DESIGN: 40% FRESH, 60% RECYCLED THERMAL WATER

OPERATIONS: 20% & 40% RECYCLED THERMAL WATER

DESIGN: CHILLERS OPERATE @ 45°F & 55°F @ 257

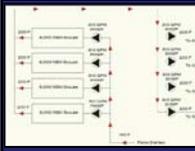
4 - 12.5 BARREL COOLING TOWERS

8 CONDENSER WATER PUMPS (1700 GPM, 40 FT. HD)

8 COLLECTOR WATER PUMPS (1200 GPM, 175 FT. HD)

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**EXISTING MECHANICAL SUMMARY**  
CENTRAL HEATING PLANT

**FOUR GAS-FIRED HOT WATER BOILERS** - 4000 MBH EACH  
SERVED - 4000 FT<sup>2</sup> TYPICAL LOADS

**DESIGN** - OPERATE WITH 100% 200°F & 100% 180°F

• PRIMARY HEATED HOT WATER PUMPS  
• 210 GPM, 11.5 FT. WC. EACH

• SECONDARY HEATED HOT WATER PUMPS  
• 210 GPM, 11.5 FT. WC. EACH

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**EXISTING MECHANICAL SUMMARY**  
GENERAL OFFICE SPACES

**UNDER FLOOR AIR DISTRIBUTION SYSTEM (UFAD)**

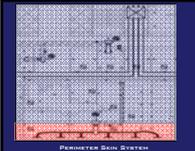
• PRESSURIZED 10" RAFF SUPPLY PLUMBING  
• SUPPLY AIR DELIVERED: 62°F - 65°F

**DESIGN GOALS**

- INCREASED ENERGY EFFICIENCY
- REDUCED MAINTENANCE COSTS
- INCREASED OCCUPANT COMFORT & CONTROL
- IMPROVED IAQ & VENTILATION
- LEED CREDITS

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**EXISTING MECHANICAL SUMMARY**  
GENERAL OFFICE SPACES

**UNDER FLOOR AIR DISTRIBUTION SYSTEM (UFAD)**

• 9 CUSTOM UFAD AHU'S RANGING BETWEEN 25,500-35,000 CFM

**PERIMETER SKIN SYSTEM**

- NARROW PERIMETER ZONE HANDLES ONLY EXTERIOR ENVELOPE HEAT GAIN/LOSSES.
- PERIMETER UNDER FLOOR TERMINAL UNITS WITH NO COILS WILL PROVIDE PERIMETER HEATING
- LARGE COOLING ONLY INTERIOR ZONE CREATED.

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**EXISTING MECHANICAL SUMMARY**  
TE LAB

**BACKGROUND:** 30% OF TOTAL FACILITY COOLING LOAD

**SYSTEM:** 20 VERTICAL AIR FLOW AHU'S FOR COOLING

- 100% OA AIR'S FOR VENTILATION
- CRAC UNITS PROVIDE COOLING

**SERVER LOADS:**

- CURRENT LOADS (SSW/SF)
- ALL EQUIPMENT RISED TO HANDLE FUTURE EXPANSION TO 1125 WS/SF

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**EXISTING MECHANICAL SUMMARY**  
COMMON BUILDING

**SYSTEM:** UPPER FLOOR SERVED BY UFAD VIA RAFF

- LOWER LEVEL SERVED BY VAV SYSTEM TO ACCOMMODATE DINING, KITCHEN, FITNESS & LOCKER ROOM FUNCTIONS.
- EXERCISE ROOM & LOCKER ROOMS WILL BE SERVED BY SEPARATE VAV SYSTEM & WILL BE VENTILATED BY ROOF MOUNTED EXHAUST FANS.

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**MECHANICAL DEPTH TE LAB**

**TRIPLE TE LAB = 30% OF TOTAL FACILITY COOLING LOAD.**

- CURRENT LOADS 85 WS/SF - 1,260 TONS OF COOLING
- FUTURE LOADS 125 WS/SF - 2,613 TONS OF COOLING

**GOAL:** INCREASE ENERGY EFFICIENCY IN LAB, WHILE ENSURING FUTURE LAB LOADS HAVE ABILITY TO BE MET.

**DESIGN OBJECTIVES:**

- RESEARCH DESIGN A MULTI-UP CHILLER PLANT WHICH COULD PROBABLY BE INCREASED OR DECREASED
- DESIGN WATER COOLED SERVER RACKS TO COMBAT THE HEAT RISE AT THE SOURCE.
- DESIGN REFRESHMENT COOLED SERVER RACKS
- COMPARE WATER VS. REFRESHMENT COOLED PERFORMANCE

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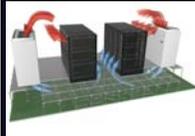
### ALTERNATIVE DESCRIPTIONS

**\*BUILT UP CHILLER PLANT**  
 \*MORE PARTS COST, WITH VERY SMALL ENERGY SAVINGS.  
 \*WOULD HAVE A PAYBACK PERIOD OF 40+ YEARS.  
 \*WOULD HAVE MORE MAINTENANCE IMPLICATIONS.  
 \*NOT A GOOD IDEA, BEING A CLIP WILL WORK BETTER.

**\*WATER & REFRIGERANT COOLED SERVER RACKS**  
 \*WOULD BE A HIGH BETTER FOCUS OF DESIGN, MINIMIZING DESIGN FAILURE OF GREEN DATA CENTERS.  
 \*CURRENT COST WOULD BE LESS, ALONG WITH GREATER ENERGY SAVINGS.  
 \*WOULD BE AN EXCELLENT FIT FOR CURRENT LOADS, AND WILL ALSO ENSURE THE ABILITY TO MEET FUTURE LOADS.

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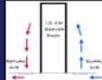
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### WATER COOLED SERVER RACKS

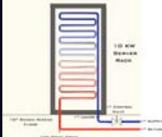
**\*CURRENT DESIGN**

- \* NOT FEASIBLE CONSIDERATION
- \* COOLED WATER FROM CLIP FEEDS AHU's, CRAC UNITS
- \* AIR IS SUPPLIED VIA UFAD SYSTEM



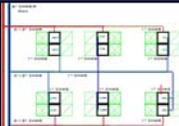
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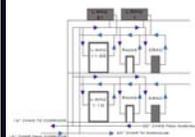
### WATER COOLED SERVER RACKS

**10 kW Water Cooled Server Rack**



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### WATER COOLED SERVER RACKS

**\*NEW DESIGN**

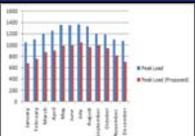
- \* INSTALL 100-120 KW WATER COOLED SERVER RACKS
- \* WILL BE 100-120 KW WATER RACKS FROM CLIP
- \* PIP BY 2-1/2" MAINS, 1" COPPER CONNECTIONS TO SERVERS

**\*BENEFITS:**

- \* WILL NOT REQUIRE LARGER CHILLERS OR PUMPS SYSTEM
- \* WILL SAVE ENERGY & MONEY IMMEDIATELY
- \* INCREASE SUSTAINABILITY WHICH IS EXTREMELY IMPORTANT FOR THE DEFENSE SYSTEM'S SERVICES
- \* ALLOWED FOR A GREATER SERVER DENSITY
- \* WILL PROVIDE ROOM ROOM FOR FUTURE EXPANSION
- \* CONFIDENCE THAT THE SYSTEM WILL BE ABLE TO HANDLE FUTURE LOADS

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### WATER COOLED SERVER RACKS

**\* First Costs**

RACKS	\$942,000
PIPING/VALVES/FITTINGS	\$200,000
LABOR	\$25,000
CONTROLS	\$93,000
TOTAL	\$1,260,000

\* PROVIDE THE WATER COOLED SERVER RACKS WILL LEAD TO A 31% REDUCTION IN ENERGY LOAD AND WILL SAVE \$1,800,000.00/YEAR ON ELECTRICITY COSTS.

\* RECOMMEND (CURRENT) REMOVE 4 AHU'S FOR A TOTAL OF \$200,000 REDUCTION IN FIRST COSTS.

\* PAYBACK PERIOD: 4.70 YEARS

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### WATER COOLED SERVER RACKS

**RESULTS:**

- \* USING WATER COOLED SERVER RACKS IS AN EXCELLENT DESIGN FOR THE LAB BUILDING AS IT WILL:
- \* REDUCE COOLING LOADS FOR THE LAB BUILDING BY 23%
- \* PROVIDE A GREATER POSSIBLE SERVER DENSITY
- \* ENSURE THAT FUTURE LOADS WILL BE MET
- \* HAVE A VERY REASONABLE PAYBACK PERIOD OF 4.70 YEARS

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### REFRIGERANT COOLED SERVER RACKS

**RESULTS:**

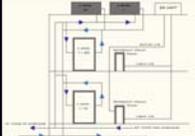
- THE INSTALLATION OF WATER COOLED SERVER RACKS SEEMS TO BE A SOUND INVESTMENT WITH REASONABLE PAYBACK AND EXCELLENT ENERGY REDUCTION.
- THE ONLY POTENTIAL PROBLEM WOULD BE A WATER LEAK WHICH COULD POTENTIALLY DAMAGE EXTREMELY EXPENSIVE AND SENSITIVE INFORMATION. ALTHOUGH THE DESIGN OF THESE RACKS TAKE THIS INTO ACCOUNT, IT MAY BE A TIGHTER SEAL TO THE OWNER.

**TOTAL:**

- DESIGNS A MORE EFFICIENT REFRIGERANT COOLED SERVER RACK SYSTEM, WHICH WILL NOT ONLY SAVE ENERGY, BUT WILL ALSO PROTECT THE SERVERS.

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### REFRIGERANT COOLED SERVER RACKS

**NEW DESIGN:**

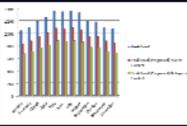
- INSTALL A REFRIGERANT BASED COOLING SYSTEM
- INSTALL REFRIGERANT COOLED RACKS
- INSTALL A DX UNIT ON THE ROOF

**REVENUES:**

- IN THE EVENT OF A LEAK, THE REFRIGERANT TURNS INTO GAS AT ROOM TEMPERATURE PREVENTING DAMAGE.
- WILL SAVE ENERGY & MONEY IMMEDIATELY INCREASE EFFICIENCY
- ALLOWS FOR A GREATER SERVER DENSITY
- WILL PROVIDE SOME ROOM FOR FUTURE EXPANSION CAPABILITY THAT THE EXISTING WILL BE ABLE TO HANDLE FUTURE LOADS.

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### REFRIGERANT COOLED SERVER RACKS

**First Costs**

- EQUIPMENT PROGRAM: \$3,000,000
- LABOR: \$700,000
- MECHANICAL OFFSET: \$700,000
- TOTAL INITIAL COST: \$2,970,000

• RESULTS THE REFRIGERANT COOLED SERVER RACKS WILL LEAD TO A 35% REDUCTION IN COOLING LOAD WHEN COMPARED TO INITIAL DESIGN AND WILL SAVE \$297,000.00/YEAR ON ELECTRICITY COSTS.

**PAYBACK PERIOD: 10.16 YEARS**

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### WATER COOLED SERVER RACKS

**RESULTS:**

- REDUCE COOLING LOADS BY 21%
- INITIAL COST: \$863,400
- ENERGY SAVINGS YEAR: \$100,000
- HAVE A PAYBACK PERIOD OF 4.79 YEARS

### REFRIGERANT COOLED SERVER RACKS

**RESULTS:**

- REDUCE COOLING LOADS BY 35%
- INITIAL COST: \$2,420,000
- ENERGY SAVINGS YEAR: \$297,000
- HAVE A PAYBACK PERIOD OF 8.16 YEARS

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### SUSTAINABILITY BREADTH RAINWATER COLLECTION SYSTEM

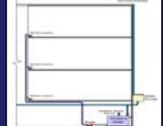
• THERE IS 22,348 SF OF ROOF AREA IN THE DISA HD WHICH COULD BE UTILIZED FOR RAINWATER COLLECTION.

**DESIGN OBJECTIVES:**

- A RAINWATER COLLECTION SYSTEM MAY BE A Nice FIT FOR THIS PROJECT
- A FEASIBILITY STUDY WAS CONDUCTED.
- THE RAINWATER STORAGE TANK WAS LOCATED AND SIZED.
- THE DISTRIBUTION PUMPS WAS SIZED

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### SUSTAINABILITY BREADTH RAINWATER COLLECTION SYSTEM

ROOF AREA: 227,566 SF  
RAINFALL: FT. MEAD, MD  
AVG. PRECIPITATION: 44.7 IN

DESIGNER YIELD OF CAPABILITY: 4,726 IN GALLONS/YEAR USABLE

THE YIELD HAS THE ABILITY TO PLUMB EVERY TOILET IN THE FACILITY.

THE LANDSCAPE ARCHITECT HAS DESIGNED ONLY VEGETATION NOT WATER IRRIGATION, THEREFORE THIS IS NOT AN OPTION.

TANKS: 21 TANKS AT 75,000 GALLONS EACH FOR EACH BUILDING

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### SUSTAINABILITY BREADTH RAINWATER COLLECTION SYSTEM

Category	Unit Price (\$)	Quantity of Unit	Subtotal (\$)
Material	25.00	100	2,500.00
Labor	15.00	100	1,500.00
Permit	500.00	1	500.00
Design	100.00	1	100.00
Installation	100.00	1	100.00
Other	100.00	1	100.00
<b>TOTAL</b>			<b>4,800.00</b>

**SCHEDULE IMPLICATIONS: MORE MONEY WOULD NEED TO BE SPENT ON MATERIALS AND LABOR. SMALL SAVINGS WOULD UNLIKELY BE WORTH THE HELP.**

**PAYBACK PERIOD: 6.2 YEARS**

**RECOMMENDATION: UNLESS YOU LIVE TO HAVE WATER, THIS SYSTEM DOES NOT MAKE ECONOMICAL SENSE. IF IRRIGATION WAS NEEDED AT THE SITE, THIS MAY MAKE MORE SENSE.**

**I DO NOT RECOMMEND THE INSTALLATION OF A RAINWATER COLLECTION SYSTEM TO FLUSH THE TOILETS IN THIS FACILITY.**

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### FINAL RECOMMENDATIONS MECHANICAL DESIGN FOR THE SERVER ROOMS

**RECOMMENDATION: BOTH WATER COOLED AND REFRIGERANT COOLED SERVER RACKS WOULD BE AN EXCELLENT FIT FOR THIS APPLICATION.**

**THE WATER COOLED RACKS HAVE A LOWER INITIAL COST & PAYBACK PERIOD, BUT HAVE LESS ENERGY THAN THE REFRIGERANT COOLED. THE REFRIGERANT COOLED WILL GIVE THE OWNER A GREATER SENSE OF CONFIDENCE.**

**OVERALL, ONE OF THESE TWO SYSTEMS SHOULD BE INSTALLED, WHICHEVER ONE IS SELECTED SHOULD BE AT THE OWNER'S DISCRETION.**

**SUSTAINABILITY BREADTH: RAINWATER COLLECTION SYSTEM**

**RECOMMENDATION: ALTHOUGH VERY SUSTAINABLE, THIS SYSTEM DOES NOT MAKE ECONOMICAL SENSE. DO NOT INSTALL RAINWATER COLLECTION SYSTEM & WATERLESS URINALS.**

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### ACKNOWLEDGEMENTS



SPECIAL THANKS TO ALL MY FRIENDS, FAMILY, AND TEACHERS.

MOST IMPORTANTLY, THANK YOU TO PAULEY, PETTY AND THE HOME CREW: LIKEY, DANNY, ANDREW, LIAM, MARK, SUNNY, JOHNSON, AND THE REST OF THE PALS. WITHOUT YOU I WOULD HAVE A LOT LESS FUN IN MY LIFE.

