

**DEA CLANDESTINE LABORATORY
TRAINING CENTER**

DAVID M. POTCHAK

**PENN STATE UNIVERSITY
ARCHITECTURAL ENGINEERING
MECHANICAL OPTION**

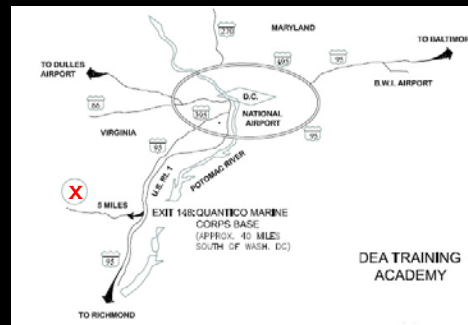
PRESENTATION OUTLINE

- **BACKGROUND INFORMATION**
- **EXISTING MECHANICAL SYSTEMS**
- **REDESIGN OBJECTIVES**
- **ALTERNATE METHODS**
- **LABORATORY HEAT RECOVERY**
- **CLASSROOM AND OFFICE HEAT RECOVERY**
- **ELECTRICAL BREADTH**
- **CONCLUSIONS**

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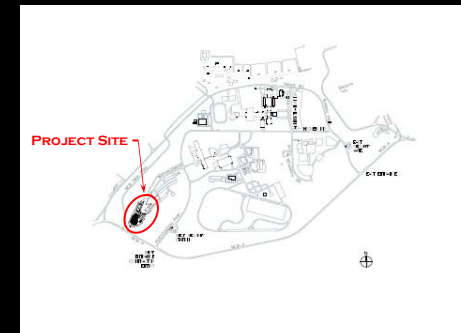
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BUILDING LOCATION



MARINE CORPS BASE - QUANTICO, VA

BUILDING LOCATION



DEA TRAINING ACADEMY CAMPUS

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ARCHITECTURE



SLAB-ON-GRADE WITH
MASONRY FACADE

ONE STORY PLUS
MECHANICAL MEZZANINE



CURVED ROOF OUTLINE
FORMS DEEP CANOPIES

ARCHITECTURE

STRIP-EFFECT OF
CLERESTORY WINDOWS



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BUILDING USE

PURPOSE: PREPARE TRAINEES FOR CAREER

MULTIPLE FUNCTIONS:

- CLASSROOMS
- LABORATORY SPACES
- PHYSICAL TRAINING AREAS
- RAID FACILITY
- FIREARMS TRAINING FACILITY
- OFFICES AND SUPPORT AREAS

BUILDING USE

LABORATORY: METH IS PRODUCED

CONTAMINANTS PRESENT IN EXHAUST:

- HYDROCHLORIC GAS
- PHOSPHINE GAS
- IODINE PARTICULATE
- VAPORIZED METHAMPHETAMINE

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HEATING SYSTEM

TWO 1,500 MBH NATURAL GAS BOILERS

HEATING HOT WATER:

- HEATING COILS IN AIR HANDLING UNITS
- CABINET UNIT HEATERS
- FINNED-TUBE RADIATORS
- VAV BOX REHEAT COILS

ULTRASONIC HUMIDIFIERS

COOLING SYSTEM

TWO 105 TON AIR-COOLED SCROLL CHILLERS

CHILLED WATER:

- COOLING COILS IN AIR HANDLING UNITS
- NO DEHUMIDIFICATION EQUIPMENT

DX UNITS IN ELECTRIC/LAN ROOMS:

- REFRIGERANT (R407C) EXTRACTS HEAT
- REMOTE CONDENSERS

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AIR HANDLING



FIVE AHU'S IN MECHANICAL MEZZANINE

AIR HANDLING UNITS

AHU's 1 & 3:

- VARIABLE FREQUENCY DRIVE
- ECONOMIZER MODE
- TOTAL: 20,300 CFM 3,590 CFM OA

AHU 2:

- VARIABLE FREQUENCY DRIVE
- 100% OA UNIT: 8,040 CFM

AHU's 4 & 5:

- CONSTANT VOLUME
- TOTAL: 2,650 CFM 1,220 CFM OA

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REDESIGN OBJECTIVES

RECOVER WASTED ENERGY FROM LABS, CLASSROOMS, AND OFFICES

LAB HEAT RECOVERY:

- **PREVENT CROSS-CONTAMINATION OF SUPPLY AIRSTREAM**
- **RECOVER LATENT ENERGY IF POSSIBLE**
- **MINIMIZE SYSTEM RECONFIGURATION**

REDESIGN OBJECTIVES

CLASSROOM AND OFFICE ENERGY RECOVERY:

- **MAINTAIN ECONOMIZER MODE CAPABILITY**
- **RECOVER LATENT ENERGY IF POSSIBLE**
- **MINIMIZE SYSTEM RECONFIGURATION**

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ALTERNATE METHODS

USING CHILLED WATER TO PREHEAT OUTDOOR AIR

BENEFITS:

- LESSENERED CHILLER AND BOILER LOADS
- WILL PREVENT CROSS-CONTAMINATION
- MINIMAL SYSTEM RECONFIGURATION

WHY NOT?

- LIMITED AVAILABILITY
- PREHEAT CONSTRAINED BY CHILLED WATER TEMPERATURE

ALTERNATE METHODS

LAB HEAT RECOVERY OPTIONS:

	Effectiveness	Latent Recovery	Availability of Use	Prevention of Cross-Contamination	Duct Reconfiguration Required
Membrane	High	Yes	Continuous	No	Yes
Enthalpy Wheel	High	Yes	Continuous	No	Yes
Chilled Water as Preheat	High	No	Limited	Yes	No
Heat Pipe	Good	No	Continuous	Yes	Yes
Run-Around Loop	Moderate	No	Continuous	Yes	No

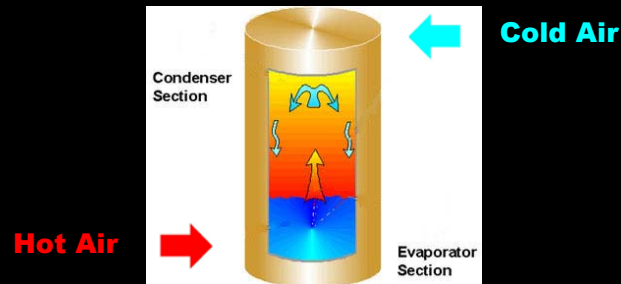
CHOOSE *HEAT PIPE*

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HEAT PIPE

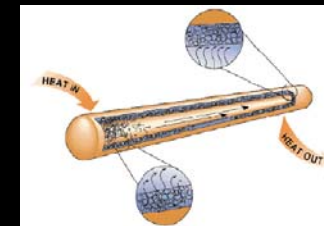
WHAT IS A HEAT PIPE?



UPRIGHT HEAT PIPE: RELIES ON BUOYANCY

HEAT PIPE

HORIZONTAL CONFIGURATION



WORKING FLUID FLOWS THROUGH WICK OR CAPILLARY STRUCTURE

CYCLES VIA PRESSURE DIFFERENTIAL

COOLING AND HEATING SAVINGS FROM ONE CONFIGURATION

CHOOSE *HORIZONTAL CONFIGURATION*

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HEAT PIPE SELECTION

HEAT PIPE TECHNOLOGY, INC.: MODEL HRM-6R

- CAPABLE OF HORIZONTAL CONFIGURATION
- SIZED FOR MAX FLOW OF 8,040 CFM
- *FINS-COAT*, EPOXY-LIKE COATING
- BYPASS DAMPER INCLUDED

HEAT PIPE MODEL

ANALYSIS:

- CONTINUOUS OPERATION THROUGHOUT YEAR
- HOURLY WEATHER DATA FROM TMY2 FILE
- ASSUME CONSTANT, TIME-WEIGHTED FLOW OF 3,560 CFM
- USE CONSTANT EFFECTIVENESS = 0.56
- USE AVERAGE UTILITY RATES

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ANALYSIS RESULTS

COOLING SAVINGS: 17,800,000 Btu/yr

HEATING SAVINGS: 166,600,000 Btu/yr

EQUIPMENT INPUT SAVINGS:

CHILLER SAVINGS: 1,980 kWh/yr

BOILER SAVINGS: 204,400,000 Btu/yr

ADDITIONAL FAN ENERGY:

FAN ENERGY: 5,900 kWh/yr

ANALYSIS RESULTS

ELECTRICAL INPUT SAVINGS:
-3,900 kWh/yr

NATURAL GAS INPUT SAVINGS:
204,400,000 Btu/yr

ELECTRICAL COST SAVINGS:
-\$319 per year

NATURAL GAS COST SAVINGS:
\$2,819 per year

TOTAL ANNUAL SAVINGS: \$2,500

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LIFE CYCLE COST ANALYSIS

PRESENT VALUE OF SAVINGS:

- 20 YEAR PERIOD
- 5% FIXED INTEREST RATE
- ASSUME NO INFLATION OR MAINTENANCE COSTS
- PV = \$49,990

INITIAL COST OF HEAT PIPE:

- ASSUME INSTALLATION IS INCLUDED
- \$1,120

LIFE CYCLE COST ANALYSIS

TOTAL PRESENT VALUE: \$48,870

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ENTHALPY WHEEL SELECTION

AIROTOR BY XETEX, INC.: MODEL AHR 1600

- SIZED FOR TOTAL MIN OA FLOW OF AHU'S 1 & 3
- BYPASS DAMPER INCLUDED

ENTHALPY WHEEL MODEL

ANALYSIS:

- OPERATES 12 HOURS PER DAY, 5 DAYS PER WEEK
- HOURLY WEATHER DATA FROM TMY2 FILE
- ASSUME CONSTANT FLOW OF 3,590 CFM
- USE CONSTANT EFFECTIVENESS = 0.77
- USE AVERAGE UTILITY RATES
- WHEEL STOPS IN ECONOMIZER MODE

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ANALYSIS RESULTS

SAVINGS:

CHILLER: \$980
BOILER: \$1,690
HUMIDIFIER: \$1,520

ADDED COST:

FAN: \$300
MOTOR: \$1,330

TOTAL ANNUAL SAVINGS: \$2,560

LIFE CYCLE COST ANALYSIS

PRESENT VALUE OF SAVINGS: \$51,300

INITIAL COST: \$14,400

TOTAL PRESENT VALUE: \$36,900

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ELECTRICAL BREADTH

INTEGRATING ENTHALPY WHEEL INTO PANEL BOARD

MOTOR:

7.5 hp, 3 Φ , 460V → 11 FLA

SIZING BRANCH CIRCUIT:

MCA = (11A)*(1.25) = 13.75 A

(NEC 2005, TABLE 310.16)

THWN, 75°C, COPPER WIRE → #12 AWG

ELECTRICAL BREADTH

EXCEPT FROM 240.4D:

*OVERCURRENT PROTECTION SHALL NOT EXCEED
20A FOR #12 AWG*

(NEC 2005, TABLE 430.52)

Percent of Full-Load Current = 200%
MOPD = (11A)*(200%) = 22.0 A

22A > 20A → MUST USE #10 AWG

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ELECTRICAL BREADTH

CIRCUIT BREAKER:

MUST BE SMALLER THAN MOPD → 20A

(NEC 2005, TABLE C-1):

1 1/2" CONDUIT (ELECTRIC METALLIC TUBING)

FINAL SIZING:

(4) # 10 AWG WIRES IN 1 1/2" CONDUIT

20A BREAKER

ELECTRICAL BREADTH

Panel Board MP-2					
CKT #	Description	VFD/T/HP/KW	Load Amps	Load kVA	Breaker Amps / Poles
1	Humidifier H-1	-	9	4.3	15 / 2
2	Humidifier H-2	-	11	5.3	15 / 2
3	Humidifier H-3	-	4	1.9	15 / 2
4	Humidifier H-4	-	3	1.4	15 / 2
5	AHU-1SF	15 VFD	21	17.4	30 / 3
6	AHU-1RF	5 VFD	7.6	6.3	15 / 3
7	AHU-3SF	20 VFD	27	22.4	40 / 3
8	AHU-3RF	7.5 VFD	11	9.1	20 / 3
9	AHU-4SF	3 HP	4.8	4	15 / 3
10	AHU-5SF	1.5 HP	2.6	2.2	15 / 3
11	RF-6	0.5 HP	1	0.8	15 / 3
12	CHWP-1	15 HP	21	17.4	30 / 3
13	CHWP-2	15 HP	21	17.4	30 / 3
14	Washer Machine	1.3 kW	1.6	1.3	15 / 3
15	Washer Machine	1.3 kW	1.6	1.3	15 / 3
16	Hot Water Booster	9 kW	32.5	9	45 / 1
17	Panel PM2 via 30kVA Trans.	30 T	8.1	2.9	50 / 3
18	SPARC Enthalpy Wheel	7.5 HP	13.75	6.6	20 / 3
19	SPARC				
20					
			TOTAL 3Φ Amps	163.75	
			TOTAL kVA	131.6	

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LIFE CYCLE COST REVISITED

TOTAL ANNUAL SAVINGS

\$5,060

TOTAL PRESENT WORTH

\$85,800

THOUGHTS

- OVERALL, GOOD REDESIGN
- PREVENTED CROSS-CONTAMINATION
- MAINTAINED ECONOMIZER MODE CAPABILITY
- CONSIDER RUN-AROUND LOOP FOR LABS?

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QUESTIONS?

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