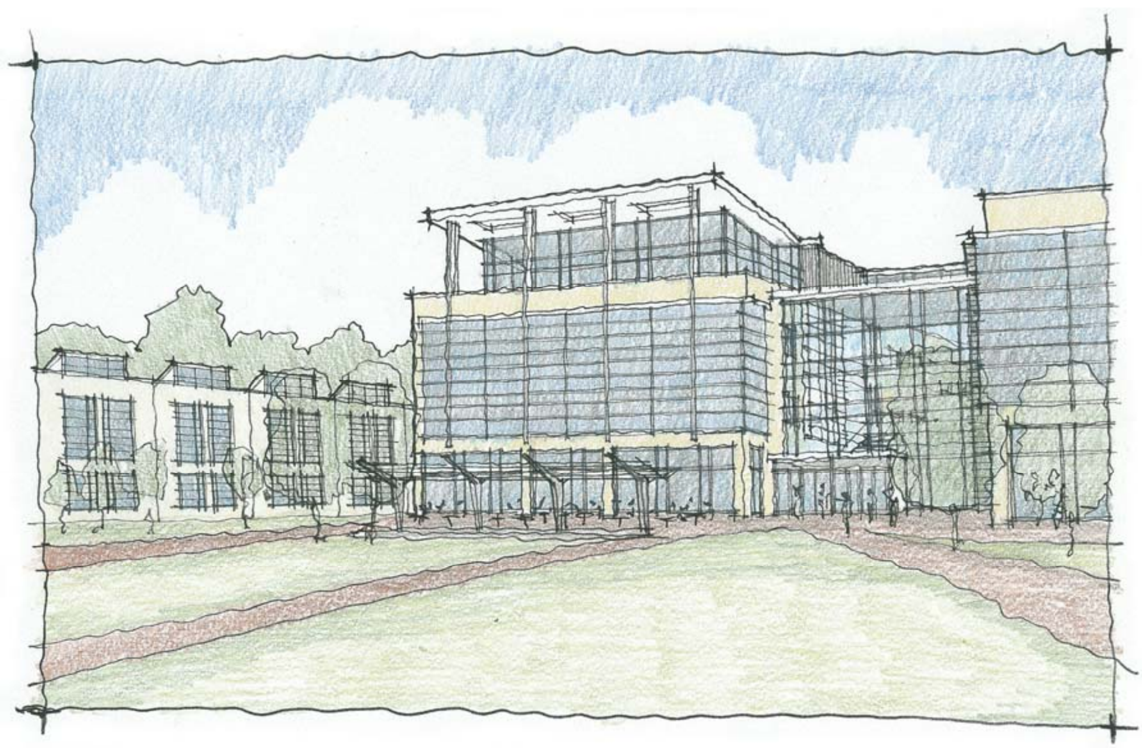
STUDENT SERVICES BUILDING
HOWARD COMMUNITY COLLEGE
COLUMBIA, MD

TECHNICAL ASSIGNMENT #3
MECHANICAL SYSTEMS EXISTING CONTIDITONS EVALUATION



Jason P. Fair
Mechanical Option

November 21, 2005

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EXECUTIVE SUMMARY:

The overall design goal for the mechanical systems is energy conservation. Therefore ASHRAE Standard 90.1 is adhered to in addition to other energy conservation techniques. The chilled and condenser water is provided by a stand-alone chilled water plant since campus chilled water service is not available. This plant is located in the basement level mechanical room and linked to the chilled water plant in the basement mechanical room of the adjacent Arts Building. This allows for select loads in each building to remain uninterrupted in the event of a failure of one plant. Since campus steam is not available, there is a heating water system located in the basement mechanical room and will be operating year round to meet the required heating loads. Two 3100MBH hot water boilers are used to meet these demands. Each boiler will be able to operate on natural gas and No.2 oil. The heated water is supplied at 200°F and returned at 160°F. Six air handling units are utilized to meet the required building loads and ventilation requirements. The air handling units are ducted to air terminal units which service each zone. Supplemental fin tube radiant heaters are also used around the perimeter walls to maintain thermal comfort near the windows.

DESIGN OBJECTIVES: (Reference 1)

1. HVAC equipment (chillers, boilers, cooling towers, and service water heaters) were selected in accordance with minimum equipment efficiency requirements of ASHRAE Standard 90.1
2. A 5^{o}F minimum deadband is maintained between each zone's heating and cooling control setpoints to prohibit concurrent operation of heating and cooling systems
3. Perimeter radiation controls for each zone are sequenced with cooling controls to preclude simultaneous heating and cooling
4. HVAC systems automatically shut down during unoccupied hours subject to building high and low temperature limits
5. Air handling systems will utilize optimum start and economizer control programs and low leakage dampers
6. A supply air isolation damper and occupancy over-ride switch is utilized at each floor served from a centralized air handling system
7. CO_2 controls are utilized to reduce ventilation air in systems serving high occupancy spaces (serving, dining, and bookstore) during periods of reduced occupancy
8. Duct insulation R values and pipe insulation thickness was selected in accordance with minimum requirements of ASHRAE Standard 90.1
9. Ducts are sealed to reduce leakage per the requirements of ASHRAE Standard 90.1
10. HVAC systems will be tested, balanced and commissioned
11. Variable air flow air handling systems with variable frequency drive fans are utilized. Zone design flow rates are reduced to maximum 30% or 4cfm/ft^2 where reheat is utilized to ensure adequate ventilation and control building humidity
12. Variable water flow heating and chilled water systems with variable frequency pump drives are utilized
13. Fan static pressure and discharge air temperature reset controls are utilized on central air handling systems to minimize energy during periods of reduced load
14. Cooling tower fans utilize variable frequency fan drives.
15. Occupancy sensors are utilized to control lights within the atrium
16. Day lighting controls are utilized to control lights within the atrium
17. Water saving plumbing fixtures are utilized to reduce water consumption

ENERGY SOURCES AND RATES:

The electric service for Howard Community College is purchased from Pepco and delivered by BGE. Below is a rate schedule (FIGURE 1) for electricity used. Summer billing months are June through September; winter billing months are October through May. Summer on-peak hours are 10am to 8 pm on weekdays; intermediate-peak hours are 7 am to 10 am, and 8 pm to 11 pm weekdays; off-peak hours are all other hours and National holidays. Winter on-peak hours are 7 am to 11 am and 5 pm to 9 pm weekdays; intermediate-peak hours are 11 am to 5 pm weekdays; off peak hours are all other hours and national holidays Billing demand is the maximum 30-minute measured demand, rounded to the nearest whole kW. Generation and Transmission Demand are billed for each kW of billing demand occurring during the on-peak period; Delivery Service Demand is billed for each kW of billing demand recorded during any rate period. The campus is served by a single utility meter. On this basis, the peak billing demand would always be measured on-peak.

ELECTRICAL RATE SCHEDULE			
COMPONENT	SUMMER	NON-SUMMER	UNIT
ELECTRIC DEMAND CHARGE	$5.13	$2.75	per KW
PEAK	$0.0624	$0.0479	per KWh
INTERMEDIATE - PEAK	$0.0624	$0.0479	per KWh
OFF - PEAK	$0.0361	$0.0332	per KWh

FIGURE 1 (REFERENCE 2)

The gas service is purchased from Washington Gas Light and is also provided by BGE. Fuel oil will be provided as back-up for the boilers, so an interruptible gas rate schedule is appropriate for this site. An analysis of gas bills for the summer of 2004 for HCC produced a current natural gas price of over $5.39 per million BTU (MMBtu). (Reference 2)

In my correspondence with the mechanical system designer no utility rebates were available to influence the design. The building was designed with a heating and cooling plant since the campus does not have district heating or cooling. One site factor that influenced the design was prompted by the new addition to the adjacent Arts Building. A prior decision made by the Howard Community College determined that the chilled water plant in the Student Services Building was to be coupled with the plant in the adjacent Arts and Humanities building.

This will provide some element of redundancy for both buildings by allowing one plant to serve selective loads in both buildings in the event of a failure of the other plant.

OUTDOOR AND INDOOR DESIGN CONDITIONS:

Outdoor design conditions are based on weather data typical for Baltimore, Md.

OUTDOOR AND INDOOR DESIGN CONDITIONS		
DESCRIPTION	DESIGN CRITERIA	
	COOLING SEASON	HEATING SEASON
Outdoor Design	93^oF_{DB} / 75^oF_{WB}	0^oF_{DB}
Indoor Design - General	75^oF_{DB}+-1^oF / $50\%_{RH}$+- 10%	70^oF_{DB}+-1^oF
Indoor Design - Kitchen	85^oF_{DB}+-2^oF / $50\%_{RH}$+- 10%	70^oF_{DB}+-2^oF
Indoor Design - Mechanical & Electrical rooms	95^oF_{DB}+-5^oF	55^oF_{DB}+-5^oF

FIGURE 2 (Reference 1)

DESIGN VENTILATION:

The design followed the criteria contained in ASHRAE Standard 62-2001, Addendum N.

SUMMARY

SPACE DESCRIPTION	AREA (sqft)	OCCUPANCY	DESIGNED VENTILATION (cfm)	SCHEDULED VENTILATION (cfm)		ASHRAE 62.1 Required OA Ventilation
						Total cfm
AHU #1 TOTALS	26,125	296	5,920	6300		3247.6
AHU #2 TOTALS	24,965	480	8,180	10300		4769.3
AHU #3 TOTALS	7,345	454	6,080	6500		3958.1
AHU #4 TOTALS	4540	126	1970	1900		1315.4
AHU #5 TOTALS	8,715	312	6,240	7200		3371
AHU #6 TOTALS	1110	20	5700	5700		5700
Note: AHU #6 is 100% outdoor air because all SA is exhausted thru kitchen hoods						

FIGURE 3 (Reference 3)

The scheduled ventilation rates (FIGURE 3) are higher for AHU's 1, 2, and 3 because there is more air exhausted from the kitchen and food service areas than is being supplied from AHU #6. See fan schedule for exact exhaust rates. (F-EA1, F-EA2, F-EA3)

DESIGN HEATING AND COOLING LOADS:

I have a large difference in the estimated loads and ventilation for AHU-5 and AHU-6 (FIGURE 4). I believe that this is from the different assumptions made during the design and modeling. AHU-6 serves the kitchen space and is serviced by a 100% outdoor air system. Also, there are many exhaust hoods in the kitchen space which exhaust more than twice as much air as is being supplied to the area. Since there more air is being exhausted than is being supplied, air from the spaces served by AHU-5 is also being exhausted. Because of this large exhaust rate the AHU's do not have to overcome the great cooling loads imposed by the many pieces of kitchen equipment such as ovens, grills, and fryers. In addition the heating loads are also supplemented by various kitchen equipment; therefore, the heating loads for AHU#6 are lower in my estimation versus the actual design.

Another possible reason for the large difference in the amount of air supplied to the space is largely due to the fact that I did not incorporate the supplemental fin tube radiant heaters along the window walls. Since the entire heating load needs to be supplied by the AHU's it requires much more air delivered to the space. The addition of fin tube radiation in my estimation would result in less air being supplied to the zones while still maintaining thermal comfort within the occupied spaces.

HEATING AND COOLING LOADS									
	DESIGN					TRACE ESTIMATED			
DESIG.	COOLING LOAD (TON)	OA VENTILATION (CFM)	SUPPLY AIR (CFM)	HEATING (MBH)		COOLING LOAD (TON)	OA VENTILATION (CFM)	SUPPLY AIR (CFM)	HEATING (MBH)
AHU-1	140	6,300	36,300	283		114.9	7,600	47,000	316.9
AHU-2	143	10,300	32,300	610		73.1	8,400	16,200	534.8
AHU-3	60	6,500	1,100	384		21	2,080	7,300	181.5
AHU-4	33	1,900	9,000	106		25.4	2,540	8,200	205.3
AHU-5	75	7,200	15,000	423		217	11,740	84,313	591.8
AHU-6	23	5,700	5,700	431		113.9	40	41,000	204.8
TOTALS	475	37,900	99,400	2,237		565.3	32,400	204,013	2,035.1
TOTAL/SQFT	213.64	0.37	0.98	0.02		179.38	0.32	2.01	0.02
	sqft/ton	cfm/sqft	cfm/sqft	mbh/sqft		sqft/ton	cfm/sqft	cfm/sqft	mbh/sqft

FIGURE 4 (REFERENCE 4)

ANNUAL ENERGY USE:

The Student Services Building at Howard Community College is currently under construction and is not due for completion until December of 2006. For that reason, there is no actual energy usage data for this building. All of the energy consumption data below is based on computer modeling, design estimations, and design assumptions. Due to the previously stated differences in the load calculations, my estimated annual energy calculations (TRACE Est.) are also different from the estimated designed annual energy consumption. Also I assumed fuel oil as the primary fuel for the boilers.

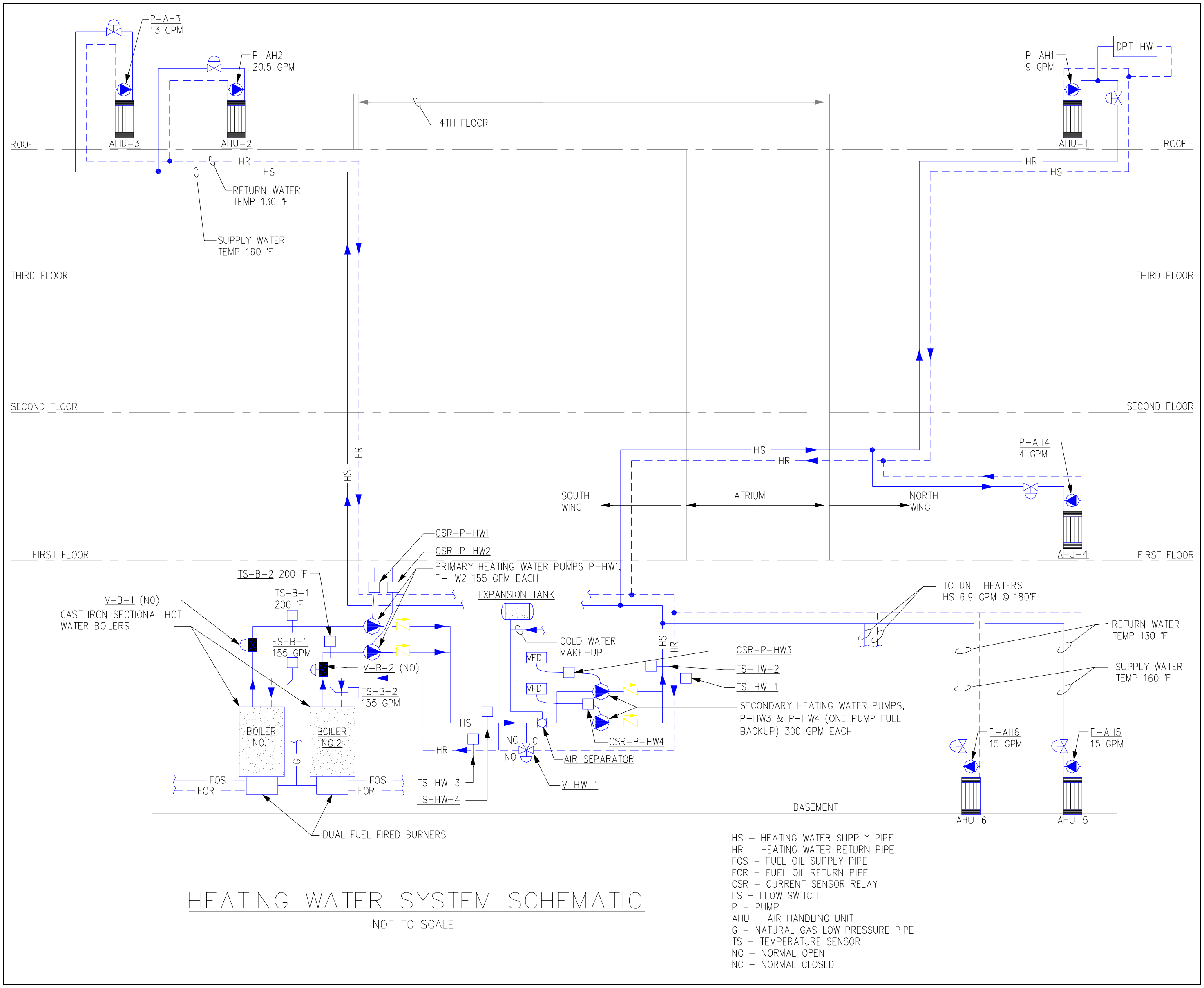
ANNUAL ENERGY CONSUMPTION (BTU's)				
UTILITY	SELECTED MECHANICAL SYSTEM (Excluding Lighting and Receptacles)	LIGHTING	RECEPTACLES & MISCELLANEOUS	TOTAL
ELECTRIC POWER	278,277,600	1,501,037,400	428,331,500	4,711,646,500
GAS	1,667,900,000	-----	-----	1,667,900,000
FUEL OIL	N/A (Standby Only)	-----	-----	-----
COAL	-----	-----	-----	-----
OTHERS	-----	-----	-----	-----
TOTAL BTU's	4,450,177,600	1,501,037,400	428,331,500	6,379,546,500
BUILDING AREA (FT^2)	104,000	104,000	104,000	104,000
ANNUAL KWH/FT^2	12.54	4.23	1.21	17.97
ANNUAL BTU/FT^2	42,790.17	14,433.05	4,118.57	61,341.79
	EPI (TOTAL ANNUAL BTU/FT^2 FROM ABOVE)			122,683.58

(REFERENCE 2)

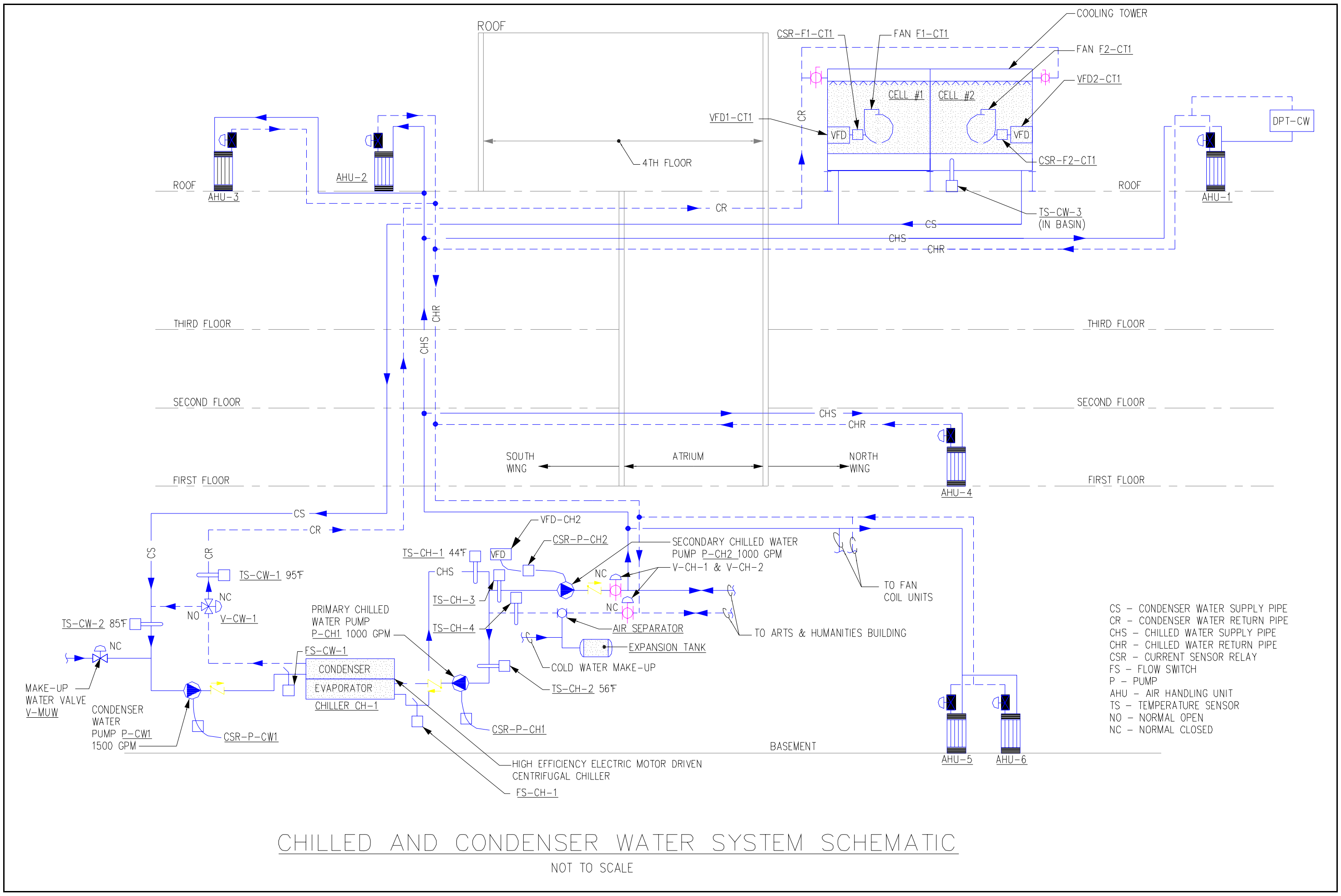
ANNUAL ENERGY CONSUMPTION (TRACE)					
Equipment Energy Consumption by - HCC Student Services Building					
	Elect Cons. (kWh)	Oil (therms)	Water (1000 gals)	Percent of Total Energy	Total Source Energy* (Btu/yr)
Primary heating	24,130.50	7,406.70		2.70%	10,267,500.00
Cooling Compressor	1,099,181.10			12.40%	112,556,400.00
Tower/Cond Fans	303,243.40		7,963.40	3.40%	31,052,200.00
Condenser Pump	269,079.30			3.00%	27,553,800.00
Circ Pumps	349,123.90			3.90%	35,750,400.00
Lighting	6,395,603.50			72.00%	654,911,300.00
Totals	8,660,764.00	7,406.70	7,963.40	100.00%	894,660,800.00
Totals /sqft (104,000sf)	83.28	0.07	0.08		8602.51
* Note: Resource Utilization factors are included in the Total Source Energy value.					

(REFERENCE 4)

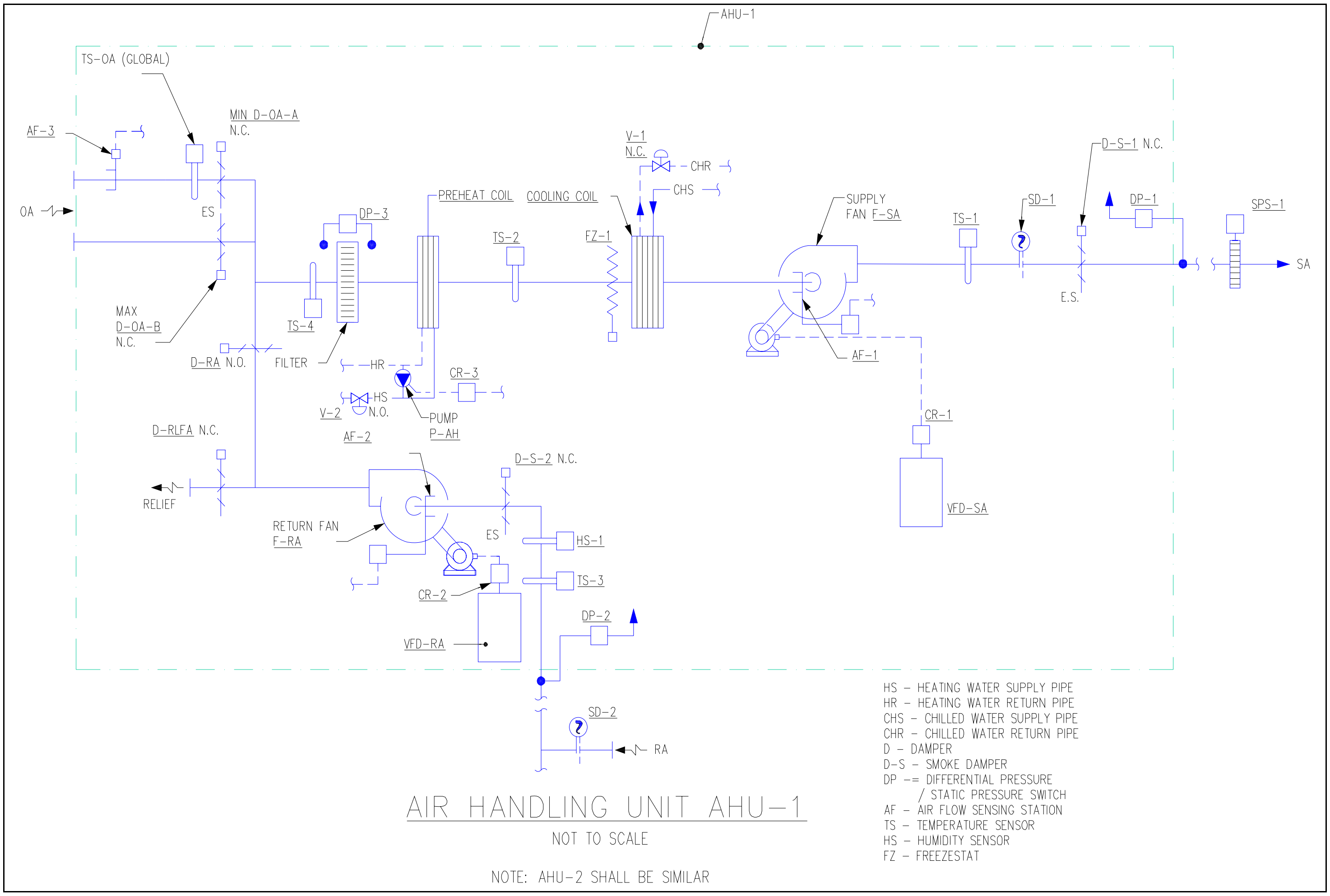
MECHANICAL SYSTEMS SCHEMATIC DRAWINGS:



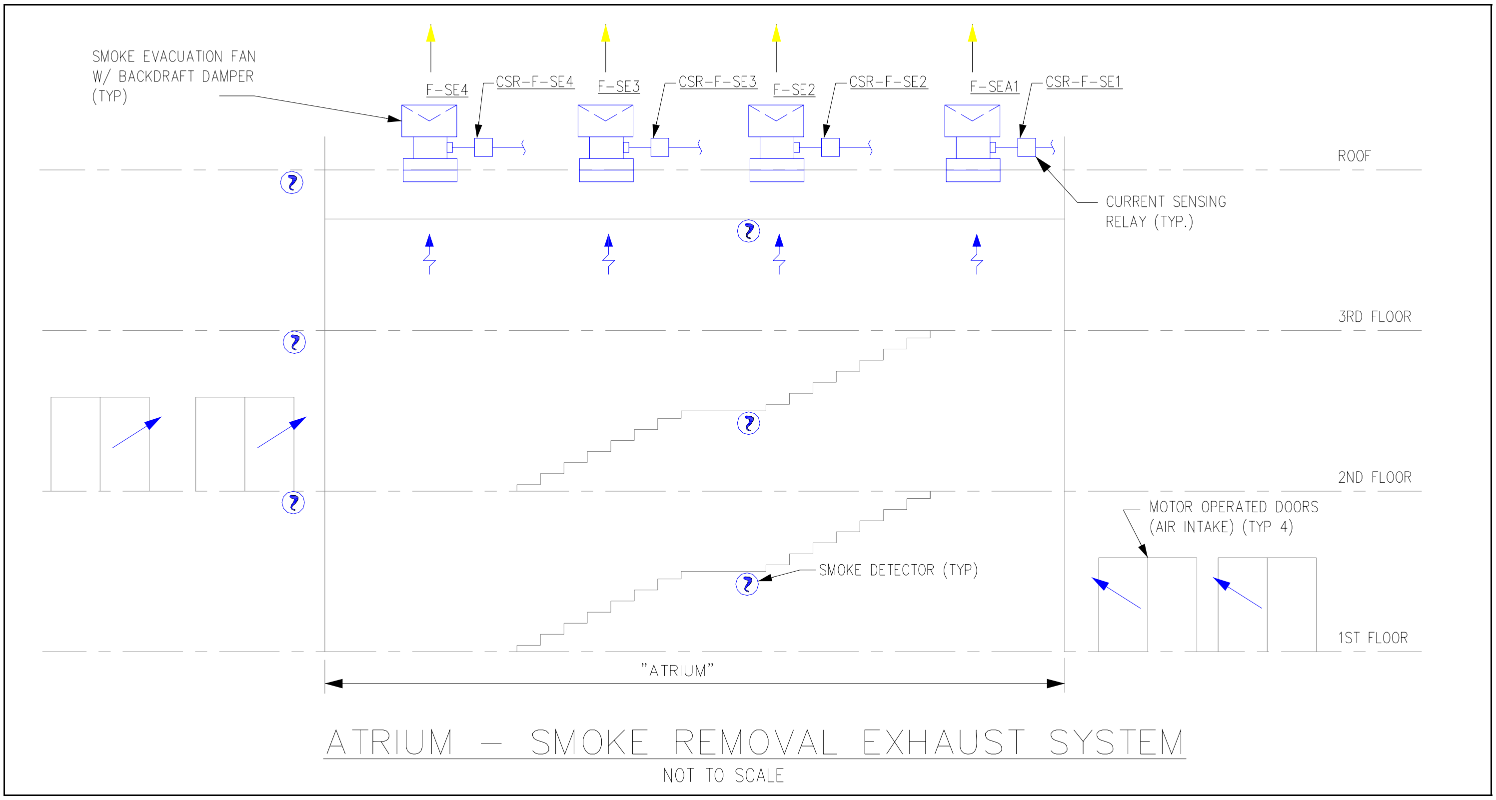
SCHEMATIC #1 (REFERENCE 5)



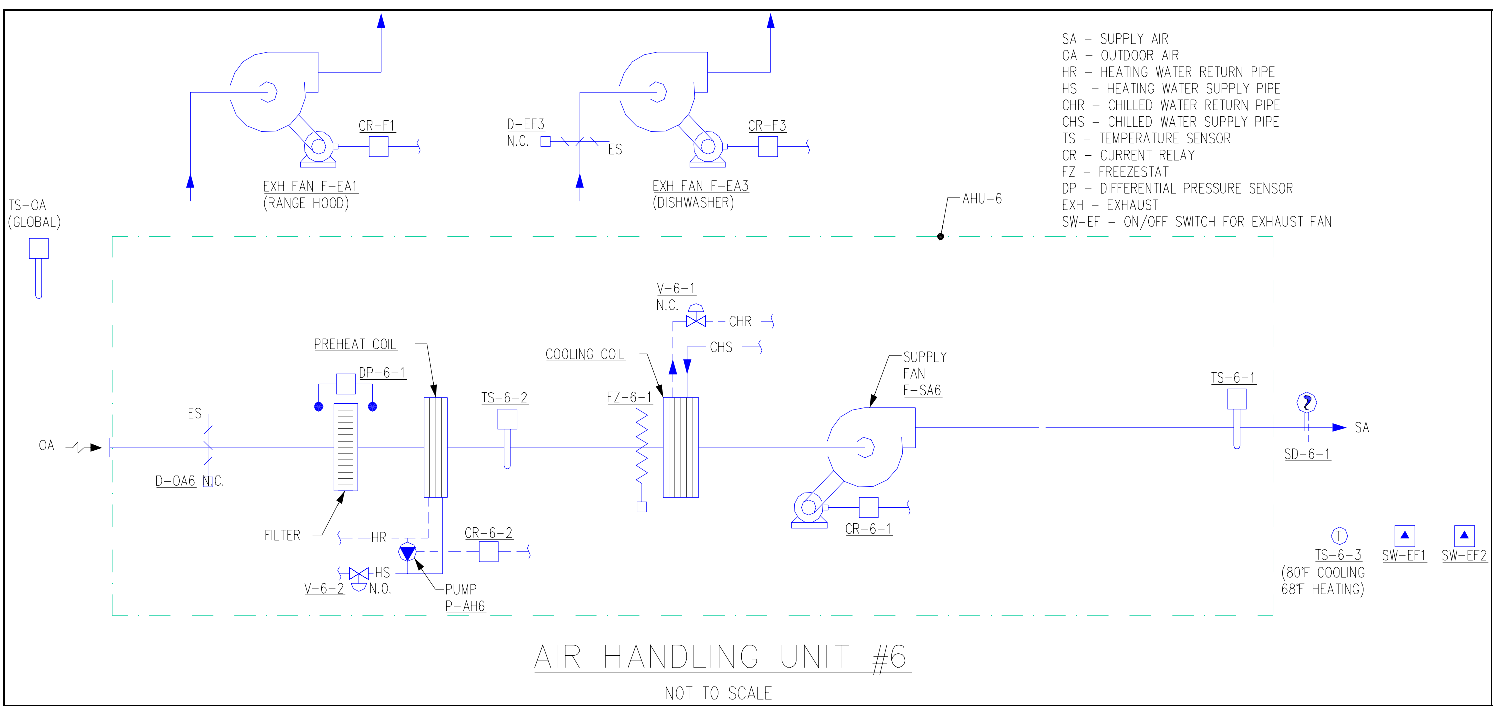
SCHEMATIC #2 (REFERENCE 5)



SCHEMATIC #3 (REFERENCE 5)



SCHEMATIC #4 (REFERENCE 5)



SCHEMATIC #5 (REFERENCE 5)

MECHANICAL EQUIPMENT SCHEDULES:

All schedule data obtained from design drawings Reference 5

AIR HANDLING UNITS — GENERAL

Desig.	Type	Location	Service	Total Airflow (cfm)		Outside Air (cfm)		Max Internal Static Pressure (inWG)
				Max	Min	occupied	unoccupied	
AHU1	Roof Top	Roof North	1st, 2nd, 3rd	36300	13100	6300	6300	3.5
AHU2	Roof Top	Roof South	South wing 2,3	32300	11300	10300	10300	3.5
AHU3	Roof Top	Roof South	South wing 4	11000	7100	6500	1800	3.5
AHU4	Indoor	MER 105	North wing 1	9000	2800	1900	1900	3.4
AHU5	Indoor	Basement MER	South wing 1 dining	15000	8700	7200	7200	3.3
AHU6	Indoor	Basement MER	South wing 1 kitchen	5700	5700	5700	5700	3.2

AIR HANDLING UNITS — COOLING COIL

Desig.	Sensible/Total Capacity (MBH)	Min Rows /Max FPI	Entering Air Temp		Leaving Air Temp		Quantity & Size	Max Face Velocity (FPM)	Max APD (in WG)	EWT (°F)	LWT (°F)	Water Flowrate (gpm)	Max WPD (ft HD)
			DB (°F)	WB (°F)	DB (°F)	WB (°F)							
AHU1	1058/1679	8 / 12	78.5	65.6	51.5	50	2 @ 10'-0" x 4'-0"	453	0.9	44	56	283	8.5
AHU2	1073/1715	8 / 12	81.4	68.2	51.5	50.6	2 @ 9'-0" x 4'-0"	448	0.9	44	56	286	9.0
AHU3	407/723	8 / 12	86.8	72.2	52.5	52	2 @ 6'-4" x 2'-0"	435	0.9	44	56	121	9.0
AHU4	261/397	8 / 12	79.3	66.3	52.5	51.5	1 @ 21.3sf	422	1.0	44	56	66	9.9
AHU5	520/905	8 / 12	84.6	70.6	52.5	51.8	1 @ 35.9sf	420	1.0	44	56	151	14.8
AHU6	166/277	8 / 12	95	78	68	66	1 @ 12sf	475	1.1	44	56	46	8.9

AIR HANDLING UNITS — HEATING COIL

Desig.	Capacity (MBH)	Min Rows /Max FPI	EAT (°F)	LAT (°F)	Quantity & Size	Max Face Velocity (FPM)	Max APD (in WG)	EWT (°F)	LWT (°F)	Water Flowrate (gpm)		Max WPD (ft HD)
										Coil	Balancing Valve	
AHU1	283	1 / 10	35	55	2 @ 8'-0" x 3'-3"	700	0.20	160	130	19	9	5.0
AHU2	610	1 / 10	5	55	2 @ 8'-0" x 3'-0"	675	0.20	160	130	41	20.5	5.0
AHU3	384	1 / 10	5	55	1 @ 6'-0" x 2'-8"	690	0.20	160	130	26	13	5.0
AHU4	106	1 / 10	20	55	1 @ 14.8sf	608	0.20	160	130	7.5	4	5.0
AHU5	423	1 / 10	10	55	1 @ 26.4sf	568	0.20	160	130	30	15	5.0
AHU6	431	2 / 10	0	70	1 @ 8.4sf	678	0.40	160	130	30	15	5.5

PUMPS

DESIG	TYPE (see spec)	LOCATION	SERVICE	WATER FLOWRATE (GPM)	HEAD (FT HD)	APPROX. IMPELLER DIA. (IN)	SUCTION X DISCHARGE (IN)	MIN PUMP EFF (%)	PUMP SPEED (RPM)	BHP / MOTOR HP	VOLTS/ PH/ HZ
P-CH1	ES	Basement MER	Primary CW	1000	35	7.9	6x5	76	1750	12/15	480/3/60
P-CH2	ES	Basement MER	Secondary CW	1000	75	9.9	6x5	83	1750	23/25	480/3/61
P-CW1	ES	Basement MER	Condenser Water	1500	75	9.8	8x6	84	1770	34/40	480/3/62
P-HW1	IL	Basement MER	Primary HW Boiler	155	20	5.4	3x3	62	1750	1.3/1.5	480/3/63
P-HW2	IL	Basement MER	Primary HW Boiler	155	20	5.4	3x3	62	1750	1.3/1.5	480/3/64
P-HW3	ES	Basement MER	Secondary HW	300	60	8.7	3x2.5	74	1750	6.5/7.5	480/3/65
P-HW4	ES	Basement MER	Secondary HW	300	60	8.7	3x2.5	74	1750	6.5/7.5	480/3/66
P-AH1	IL	AHU-1	AHU-1 Preheat Coil Circulator	9	20	4.9	1x1	28	1725	0.2/0.25	120/1/60
P-AH2	IL	AHU-2	AHU-2 Preheat Coil Circulator	20.5	20	5.1	1x1	43	1725	0.3/0.33	120/1/60
P-AH3	IL	AHU-3	AHU-3 Preheat Coil Circulator	13	20	5.3	1x1	35	1725	0.2/0.33	120/1/60
P-AH4	IL	AHU-4	AHU-4 Preheat Coil Circulator	4	20	4.8	1x1	15	1725	0.2/0.25	120/1/60
P-AH5	IL	AHU-5	AHU-5 Preheat Coil Circulator	15	20	5.3	1x1	38	1725	0.2/0.33	120/1/60
P-AH6	IL	AHU-6	AHU-6 Preheat Coil Circulator	15	20	5.3	1x1	38	1725	0.2/0.33	120/1/60
P-SE1	--	Basement MER	Sewage Ejector	75	20	--	--	--	1760	0.8/1	480/3/60
P-SE2	--	Basement MER	Sewage Ejector	75	20	--	--	--	1760	0.8/1	480/3/61
P-SP1	--	Basement MER	Sump Pump	100	20	--	--	--	1760	1.5/2	480/3/62
P-SP2	--	Basement MER	Sump Pump	100	20	--	--	--	1760	1.5/2	480/3/63
P-SP3	--	Elevator #1	Elevator Sump Pump	75	12	--	--	--	3500	--/0.5	480/3/64
P-SP4	--	Elevator #2,3	Elevator Sump Pump	75	12	--	--	--	3500	--/0.5	480/3/65
P-HWR1	--	Basement MER	Dom. HW Recirc (110^{o}F)	5	20	--	3/4x3/4	--	--	--/0.33	120/1/60
P-HWR2	--	Basement MER	Dom. HW Recirc (140^{o}F)	5	20	--	3/4x3/4	--	--	--/0.33	120/1/60
P-RHC1	IL	Basement MER	HW Reheat Coil	16	20	5.0	1x1	39	1725	0.2/0.33	120/1/60

PROPELLER UNIT HEATERS & CABINET UNIT HEATERS								
DESIG	TYPE	LOCATION	MINIMUM CAPACITY (NOTE 1)	AIRFLOW @ 60°F EAT (CFM)	WATER FLOWRATE @ 180°F EWT (GPM)	Max WPD (FT HD)	ELECTRICAL	
							LOAD (NOTE 2)	VOLTS/PH/HZ
UH-1	PROP	BASEMENT MER	22.5	530	2.3	0.2	1/20	120/1/60
UH-2	PROP	BASEMENT MER	22.5	530	2.3	0.2	1/20	120/1/60
UH-3	PROP	BASEMENT MER	22.5	530	2.3	0.2	1/20	120/1/60
UH-4	PROP	MECH RM 105	22.5	530	2.3	0.2	1/20	120/1/60
UH-5	PROP	ABOVE LOADING DOCK	5.0	530	---	---	6	480/3/60
UH-6	PROP	CORRIDOR C15	22.5	530	2.3	0.2	1/20	120/1/60
CUH-1	CAB	STAIR S11	48.0	700	3.2	4.7	0.1	120/1/60
CUH-2	CAB	VESTIBULE V11	16.7	1000	---	---	25	480/3/60
CUH-3	CAB	CORRIDOR C16	48.0	700	3.2	4.7	0.1	120/1/60
CUH-4	CAB	VESTIBULE V21	8.0	500	---	---	12	480/3/60

NOTES:

1. CAPACITY EXPRESSED IN MBH FOR HYDRONIC HEATERS AND KW FOR ELECTRIC HEATERS
2. ELECTRIC LOAD EXPRESSED IN HOTOR HP HYDRONIC HEATERS AND FULL LOAD AMPS FOR ELECTRIC HEATERS UNLESS NOTED OTHERWISE.

FAN COIL UNITS												
DESIG	AIR FLOW (CFM)	EXT S.P. (INWG)	MOTOR (HP)	COOLING CAPACITY					HEATING CAPACITY			ELECTRICAL DATA V/PH/HZ
				ENT. AIR DB (°F)	ENT. AIR WB (°F)	TOTAL (MBH)	SENSIBLE (MBH)	GPM @ 44°F EWT	ENT. AIR DB (°F)	TOTAL (MBH)	GPM @ 180°F EWT	
FCU-1	2800	0.5	1.5	90	78	221	105	37	---	---	---	480/3/60
FCU-2	2800	0.5	1.5	90	78	221	105	37	---	---	---	480/3/60
FCU-3	2400	0.5	1.5	90	78	135	66	23	50	51.8	3.5	480/3/60
FCU-4	900	0.25	0.1	72	60.5	19.8	15.5	4.2	70	34.8	2.3	120/1/60
FCU-5	900	0.25	0.1	72	60.5	19.8	15.5	4.2	70	34.8	2.3	120/1/60
FCU-6	900	0.25	0.1	72	60.5	19.8	15.5	4.2	70	34.8	2.3	120/1/60

FANS									
DESIG	TYPE (see spec)	SERVICE	AIRFLOW (CFM)		TOTAL STATIC PRESSURE (INWG)	APPROX. WHEEL DIAMETER (IN)	SPEED (RPM)	BHP / MOTOR HP	VOLTZ/PH/HZ
			MAX	MIN					
F-EA1	UTILITY SET	KITCHEN 123 EXHAUST	5700	5700	4.00	16.5	2789	7.3/10	460/3/60
F-EA2	UTILITY SET	FOOD SERVING 122 EXHAUST	6650	6650	4.00	20	1972	6.6/7.5	460/3/60
F-EA3	UTILITY SET	DISHWASHER 123 EXHAUST	615	615	3.00	9	2877	0.5/0.75	460/3/60
F-EA4	CENTRIFUGAL ROOF VENTILATOR	TOILET EXHAUST	2700	2700	1.00	16	1305	0.88/1.5	460/3/60
F-EA5	CENTRIFUGAL ROOF VENTILATOR	TOILET R41 & R42 EXHAUST	850	850	1.00	14	1557	0.29/0.33	120/1/60
F-EA6	IN-LINE CENTRIFUGAL	CATERING STORAGE 127	550	550	1.50	8	2290	0.5/0.75	460/3/60
F-EA7	IN-LINE CENTRIFUGAL	BASEMENT MER 001	3300	3300	1.00	14	2004	1.6/2.0	460/3/60
F-EA8	IN-LINE CENTRIFUGAL	TOILET ROOM 363 & 364	200	200	1.00	7	1941	0.23/0.33	120/1/60
F-EA9	CEILING MOUNTED FAN	TOILET 001D	75	75	0.50	--	1500	--/40W	120/1/60
F-EA10	CENTRIFUGAL ROOF VENTILATOR	PANTRY #402	600	600	0.50	8	1531	0.13/0.16	115/1/60
F-SE1	SMOKE REMOVAL	SMOKE EVACUATION	31750	31750	0.75	54	698	9/10	460/3/60
F-SE2	SMOKE REMOVAL	SMOKE EVACUATION	31750	31750	0.75	54	698	9/10	460/3/60
F-SE3	SMOKE REMOVAL	SMOKE EVACUATION	31750	31750	0.75	54	698	9/10	460/3/60
F-SE4	SMOKE REMOVAL	SMOKE EVACUATION	31750	31750	0.75	54	698	9/10	460/3/60
F-VA1	IN-LINE CENTRIFUGAL	ELEC. RM VENT AIR	5500	5500	1.75	20	1341	3/5	460/3/60
F-CA1	IN-LINE CENTRIFUGAL	COMBUSTION AIR	3300	1900	1.50	14	2124	2/5	460/3/60
F-SA1	PLENUM	AHU-1 SUPPLY	36300	13100	7.00	44	1160	56/60	460/3/60
F-RA1	PLENUM	AHU-1 RETURN	30000	6800	2.00	49	615	14/20	460/3/60
F-SA2	PLENUM	AHU-2 SUPPLY	32300	11300	6.80	44	1105	49/60	460/3/60
F-RA2	PLENUM	AHU-2 RETURN	30000	9000	1.50	49	557	10/15	460/3/60
F-SA3	PLENUM	AHU-3 SUPPLY	11000	7100	5.70	25	2080	15/20	460/3/60
F-RA3	PLENUM	AHU-3 RETURN	8500	4600	1.50	32	731	3/5	460/3/60
F-SA4	DIDW	AHU-4 SUPPLY	9000	2800	6.00	20	2010	13/15	460/3/60
F-RA4	DIDW	AHU-4 RETURN	8000	1800	1.50	20	1204	3/5	460/3/60
F-SA5	DIDW	AHU-5 SUPPLY	15000	8700	6.10	22	1629	22/25	460/3/60
F-RA5	DIDW	AHU-5 RETURN	7800	1500	1.90	22	1082	4.0/7.5	460/3/60
F-SA6	DIDW	AHU-6 SUPPLY	5700	5700	4.20	15	1367	6.3/10	460/3/60

DUCTLESS SPLIT SYSTEM						AIR COOLED CONDENSING UNIT			
DESIG	DX COOLING CAPACITY			MOTOR		GENERAL		MINIMUM COOLING CAPACITY (MBH) @45°F SUCT TEMP & 105°F OA TEMP	MCA
	TOTAL (MBH)	SENSIBLE (MBH)	CFM	HP	VOLTS/PH/HZ	DESIG	SERVICE		
DSSE-B1	15.64	12.62	520	1/16	208/1/60	DSSC-B1	DSSE-B1	18.5	20
DSSE-B2	19.09	13.8	530	1/16	208/1/60	DSSC-B2	DSSE-B2	21	20
DSSE-1N	12.05	8.44	310	1/16	208/1/60	DSSC-1N	DSSE-1N	13.25	15
DSSE-1S	12.05	8.44	310	1/16	208/1/60	DSSC-1S	DSSE-1S	13.25	15
DSSE-2N	12.05	8.44	310	1/16	208/1/60	DSSC-2N	DSSE-2N	13.25	15
DSSE-2S	12.05	8.44	310	1/16	208/1/60	DSSC-2S	DSSE-2S	13.25	15
DSSE-3N	12.05	8.44	310	1/16	208/1/60	DSSC-3N	DSSE-3N	13.25	15
DSSE-3S	12.05	8.44	310	1/16	208/1/60	DSSC-3S	DSSE-3S	13.25	15

CHILLER	
GENERAL	
DESIGNATION	CH-1
LOCATION	BASEMENT MER
NOMINAL COOLING CAPACITY (TONS)	500
MAX CHILLER INPUT (KW)	271.5
EVAPORATOR PERFORMANCE	
ENTERING CHILLED WATER TEMP (°F)	56
LEAVING CHILLED WATER TEMP (°F)	44
CHILLED WATER FLOW RATE (GPM)	1000
FOULING FACTOR (HR-SQ FT-°F)/BTU	0.0001
MAXIMUM WATER PRESSURE DROP (FT HD)	12.37
NUMBER OF PASSES	2
CONDENSER PERFORMANCE	
ENTERING CONDENSER WATER TEMP (°F)	85
LEAVING CONDENSER WATER TEMP (°F)	95
CONDENSER WATER FLOWRATE (GPM)	1500
FOULING FACTOR (HR-SQ FT-°F)/BTU	0.00025
MAXIMUM WATER PRESSURE DROP (FT HD)	19.78
NUMBER OF PASSES	2
COMPRESSOR PERFORMANCE	
VOLTAGE	460
PHASE	3
FREQUENCY (HZ)	60
FULL LOAD AMPS (FLA)	369.2
MAXIMUM KW/TON	0.54
MAXIMUM NPLV (KW/TON)	0.47
PHYSICAL	
MAX LENGTH (FT-IN)	11'-3"
MAX WIDTH (FT-IN)	7'-4"
MAX HEIGHT (FT-IN)	9'-6"

BOILERS

GENERAL	
DESIGNATION	B-1 & B-2
LOCATION	BASEMENT MER
SERVICE	BLDG HEATING WATER
TYPE	CAST IRON SECTIONAL
BOILER CAPACITY	
GROSS I-B-R OUTPUT (MBH)	3098
ENTERING WATER TEMP (^oF)	160
LEAVING WATER TEMP (^oF)	200
WATER FLOW RATE (GPM)	155
BURNER	
FUEL TYPE	#2 FUEL OIL / NATURAL GAS
MIN GAS INLET PRESSURE (IN WG)	2
MIN BURNER INPUT CAPACITY	
OIL (GPH)	31.5
GAS (MBH)	3600
ELECTRICAL	
VOLTAGE	460
PHASE	3
FREQUENCY (HZ)	60
BURNER MOTOR HORSEPOWER	2
PHYSICAL	
APPROXIMATE LENGTH (IN)	161"
APPROXIMATE WIDTH (IN)	42"
APPROXIMATE HEIGHT (IN)	66"
FLUE DIAMETER (IN)	16"
OPERATING WEIGHT (LBS)	12467

COOLING TOWER	
GENERAL	
DESIGNATION	CT-1
LOCATION	ROOF
SERVICE	BLDG CONDENSER WATER
NOMINAL COOLING CAPACITY (TONS)	500
NUMBER OF CELLS	1
BASIN HEATER QUANTITY & CAPACITY (KW)	2 @ 5 KW
PERFORMANCE	
ENTERING WATER TEMP (^oF)	95
LEAVING WATER TEMP (^oF)	85
AMBIENT AIR WET BULB TEMP (^oF)	79
WATER FLOWRATE PER UNIT (GPM)	1500
MAXIMUM WATER PRESSURE DROP (PSIG) (INCLUDES ELEVATION & INTERNAL PIPING LOSS)	----
FAN DATA	
FAN TYPE	CENTR
FAN QUANTITY & HORSEPOWER	2 @ 30 HP
FAN CONTROL	VFD
PHYSICAL	
APPROXIMATE LENGTH (FT-IN)	18'-0"
APPROXIMATE WIDTH (FT-IN)	11'-10"
APPROXIMATE HEIGHT (FT-IN)	13'-11"
ELECTRICAL	
FULL LOAD AMPS (FLA)	---
VOLTAGE	460
PHASE	3
FREQUENCY (HZ)	60

SYSTEM OPERATIONS:

Sequence of Control- Heating Water System: (SEE SCHEMATIC #1)

System operation is controlled by “START-STOP" modes of the Direct Digital Control (DDC) System. DDC software menus shall allow the operator to select “START-STOP" modes in addition to the operating modes. The menus shall be selectable through the local DDC panel in the mechanical room. All set points shall be variables in the DDC programs and be adjustable by the user through a keyboard interface.

Temperature sensors TS-HW-1, TS-HW-2, TS-HW-3, TS-HW-4, TS-B-1, and TS-B-2 shall monitor the heating water system temperatures through the DDC system.

The DDC system shall measure percent speed and alarm status of each VFD through a 2-way communication connection to the DDC network.

Current sensor relays (CSR) shall signal the DDC system to provide operating status of each pump and each boiler burner.

Safety and Alarms: each boiler will be furnished with microprocessor-based flame safety controls. Internal safety controls (low gas pressure, low water level, low combustion air, etc) shall automatically shutdown a boiler in the event of abnormal conditions. A general alarm will be annunciated through the DDC system if a boiler shuts down.

A manual emergency switch SW-1 at each entrance to the boiler room shall de-energize the boilers and the system pumps, and annunciate an alarm through the DDC system, stating “EMERGENCY BOILER SHUTDOWN.”

When the system is stopped the boilers and pumps shall be de-energized, and valves shall return to their normal positions. (REFERENCE 5)

Sequence of Control- Chilled Water System: (SEE SCHEMATIC #2)

The chiller system shall be indexed to start or stop by the Direct Digital Control (DDC) System. All setpoints shall be variables in the DDC programs and be adjustable by the user through a keyboard interface.

Temperature sensors TS-CH-1, TS-CH-2, TS-CH-3, AND TS-CH-4 shall monitor the primary and secondary chilled water loop temperatures through the DDC system. Temperature sensors TS-CW-1, TS-CW-2 AND TS-CW-3 shall monitor the condenser water loop temperatures.

Current sensor relays (CSR) shall signal the DDC system to provide operating status of each pump and each cooling tower fan.

The DDC system shall measure percent speed and alarm status of each VFD through a 2-way communication connection to the DDC network.

The chiller will be furnished with a microprocessor-based chiller control panel (CCP) with operating and Safety controls. Internal safety controls furnished with the chiller (high pressure, high temperature, low oil, low voltage, etc) shall automatically shutdown the chiller in the event of abnormal conditions. A general alarm will be annunciated through the DDC system if the chiller shuts down.

Flow switches, FS-CH-1 and FS-CW-1 shall signal the DDC to provide status of flow conditions through the chiller's evaporator and condenser.

Level controller provided by the tower manufacturer shall signal the DDC system to alarm high and low water levels in the cooling tower basin.

Sequence of Control- Air Handling Unit #1: (SEE SCHEMATIC #3)

The AHU shall be indexed to start or stop by the Direct Digital Control (DDC) System command. The DDC system shall also select the AHU's operating mode "OCCUPIED" or "UNOCCUPIED" When started the AHU shall operate in the selected operating mode as determined through the DDC system occupancy Schedule program. An occupied / unoccupied schedule for each floor served by the system shall be established in the program. When indexed to stop, the supply, return, and associated exhaust fans are off and the controls are returned to their normal position.

Temperature sensors TS-1, TS-2, TS-3, TS-4, and TS-OA shall signal the DDC system to monitor system air temperatures. Humidity sensor HS-1 shall signal the DDC system to monitor system RH.

Fan inlet measuring probes AF-1 and AF-2 and their associated transmitters shall monitor air flow of their respective fans through the DDC system. Thermal dispersion air flow probe AF-3 and its associated transmitter in the OA plenum shall monitor system minimum Outdoor Air flow.

The DDC system shall measure percent speed signal, alarm status, and diagnostic conditions of each VFD through a 2-way communication connection to the DDC network.

Sensors not utilized as inputs for control shall be utilized for monitoring AHU system parameters through the DDC system.

Setpoints shall be variables in the DDC programs and adjustable by the operator.

Sequence of Control- Atrium Smoke Removal System: (SEE SCHEMATIC #4)

The Fire Detection and Alarm System (FDAS) shall be wired and interlocked to provide immediate operation of the smoke evacuation system upon smoke detection or sprinkler flow in the atrium. The following automatic operations shall occur upon receipt of a signal from the FDAS.

All supply and return fans of all AHU's shall be de-energized and all motor operated dampers associated with those AHU's shall return to their normal operation.

Two sets of exterior doors on the 1st floor and two sets of exterior doors on the 2nd floor shall automatically open fully.

Smoke evacuation fans shall start and run continuously.

A control station shall be provided at the location of the FDAS fireman's station, in a recessed locked cabinet and provide the following push buttons:

"TEST", "CANCEL, and "RESUME HVAC"

Sequence of Control- Air Handling Unit #6: (SEE SCHEMATIC #5)

The AHU shall be indexed to start or stop by the Direct Digital Control (DDC) System command. When commanded to start and local range hood fan switch SW-EF1, ("ON"- "AUTO" – "OFF") is in the "AUTO" position, the system shall operate thru the DDC system occupancy schedule program either in the occupied or unoccupied mode. When SW-EF1 is in the "ON" position the system shall operate in the occupied mode, and when SW-EF1 is in the "OFF" position the system shall operate in the unoccupied mode. When commanded to stop the supply fan F-AS6 and exhaust fan F-EA1 shall be off and the controls returned to their normal position.

Switch SW-EF2 ("ON" – "OFF") shall control fan F-EA3, In the ON" position, the fan shall start and run continuously, an damper D-EF3 shall open, in the "OFF" position the fan shall be off and D-EF3 shall be closed.

Temperature sensor TS-6-1, TS-6-2, TS-6-3 and TS-OA shall signal the DDC system to monitor system air temperature. Sensors not utilized as inputs for control shall be utilized for monitoring AHU system parameters through the DDC system.

SYSTEM CRITIQUE:

The mechanical system design of the Student Services Building at Howard Community College provided by Mueller Associates is and effective and efficient solution to the environmental requirements of the building. Through the use of energy efficient components, the design team has developed building mechanical systems that will provide many years of efficient operation. The design has sufficiently met the objectives set forth by the owner in the schematic design phase. Use of occupancy sensors, CO_2 sensors, and occupancy schedules ensures that the mechanical systems will operate only when necessary. This prevents expensive continuous operation of systems which would use excess utility fuel. The Direct Digital Control (DDC) System is a good design to maintain efficient operation. However, this will require the need for thorough and complete commissioning of the systems. Once the systems are running properly the facility engineers will be able to quickly identify any malfunctions in the systems and then find the proper solution. The DDC system also allows for the recognition of required maintenance such as changing air filters. The overall design is very comprehensive, and once installed and commissioned properly, will provide the owners with a cost effective and energy saving mechanical system.

REFERENCES:

1. Schematic Design book for Student Services Building at Howard Community College June 9, 2004 by DESIGN COLLCTIVE, INC.

2. Life Cycle Cost Analysis of Heating and Cooling System Alternatives for The Student Services Building at Howard Community College October 19, 2004 by Mueller Associates INC.

3. Technical Assignment #1 ASHRAE STANDARD 62.1- 2004 VENTILATION COMPLIANCE EVALUATION

4. Technical Assignment #2 Building and Plant Energy Analysis

5. Drawing set for Student Services Building at Howard Community College Construction Documents 4/22/05 MEP systems Designed by Mueller Associates