HEATING FACILITIES

Blue Mountain Community College
Pendleton, Oregon

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The following study is the result of a request to the Geo-Heat Center for Technical Assistance.

Introduction

Blue Mountain Community College campus consists of five major buildings totalling about 193,000 square feet in area. Four of these buildings are heated using hot water circulating systems, and the fifth by a low pressure steam system. The boilers for each of the systems are natural gas fired. Annual costs for natural gas amounted to about $63,000 in 1979, up almost 14% from the prior year. School officials are concerned about this increasing fuel cost. An energy audit by a consulting firm has resulted in recommendations which should reduce the amount of fuel used. During March of 1980, a successful agricultural well was drilled adjacent to the campus. During a twelve hour test this well produced 780 gallons per minute of 65°F water. The Center has been asked to determine if this water can be used to heat the campus.

Summary of Conclusions

Heating the campus utilizing a heat pump system is possible using readily available and proven equipment.

Annual energy saving in natural gas will amount to 98,400 therms. This is an 82% reduction in the annual usage forecast after implementation of recommendations made as a result of the energy audit. The first year value of the natural gas saved is $49,200. This savings, less operating costs, when applied with escalation consideration over a period of twenty years, indicates that a capital investment of $367,500 can be justified. This assumes the project would be financed with 8% tax-free bonds.

A system design was developed, new equipment sized, needed modifications identified, and major items estimated. However, an overall estimate of the capital cost was not made. Therefore, a conclusion cannot be made as to the economic feasibility of this project.

Description of the Heat Pump System

Figure 1, Flow Diagram of the Heating System, shows the basic plan for utilizing heat pumps to extract heat from the well water, then supplying a circulating water stream at an elevated temperature that is compatible with space heating equipment. Each of the major buildings is equipped with a heat pump, with the exception of the Health-Education Building which is supplied by the heat pump located in McCrae Activity Center Details on the heat pumps are shown on Table 1, Heat Pump Duty. This study is based on Westinghouse "Templifier" heat pumps.

Referring to Figure 1, the production well is 600 feet deep and fully cased as shown. Tests on the existing agricultural well indicate that the required 719 gallons per minute is available from 600 feet. .A deep well turbine pump with variable speed drive will require a 100 horsepower electric motor to make the lift and develop the delivery pressure required by the system. A pumping water level of 450 feet, and injection water level of 150 feet, is anticipated at design flow conditions. The well water is pumped parallel through the evaporators of the four individual heat pumps, then to the injection well where the injection temperature of the water is 53.6°F. Figure 2 shows the routing and size of the buried well water system. Uninsulated PVC pipe is used with both supply and return lines buried in the same trench as indicated in Figure 2. Heat loss to the return line is less than 1°F at design flow, and there is very little chance that either line will freeze if a flow is maintained.

Again referring to Figure 1, heat pump condenser water at 130°F circulates through the space heating equipment. At McCrea, a plate heat exchanger isolates this circulating water from the hot water that is used for potable purposes, and heating the swimming pool. A makeup stream of cold domestic water is needed.

Table 2, Method of Heat Utilization, tabulates the manner in which the heating is accomplished in the five buildings. From this table it can be calculated that 38.5% of the total duty is accomplished by new extended surface heat transfer equipment. This is necessitated by the lower temperature available from the heat pumps as compared to the existing boiler facilities. A more detailed explanation of the equipment required to do the heating job is contained in the Appendix.

Energy Balance

The basis for the energy balance is an energy audit conducted by Keith Kruchek Consulting Engineers, Inc. Table 3, 1978 Annual Energy Usage Summary, tabulates the natural gas and electricity used by each building. It should be noted that the electricity used is reported as "oil required to produce". A conversion of 11,600 BTU/KWH is used rather than the normal conversion factor of 3,413 BTU/KWH. This reflects the gross inefficiency of present day electrical power plants where 70% of the available energy is wasted. Table 4, Estimated Energy Consumption Goal, is similar to Table 3, but reflects the usage after implementation of recommendations made as a result of the energy audit. Again, electricity is reported as "oil required to produce". Table 5, Energy Consumption Comparison, compares the energy usage if the college operates with the existing boiler system, to the energy used by the college after installation of the heat pump system. The "existing system" portion of this table is developed directly from Table 4. However, electrical usage is reported "as purchased", and does not reflect the inefficiency of power plants. That right hand column of Table 5 shows that total energy consumption will drop from 18.75 billion BTU/YR to 11.53 billion BTU/YR, a savings of 7.22 billion BTU/YR.

Heat pump duties as reported in Table 1 were developed from the "proposed system" portion of Table 5.

Capital and Operating Costs

An overall estimate of the capital cost was not made. The supplier indicates that the four Westinghouse heat pumps would cost $200,000. An alternate, which was not investigated, would use a single Moded TPE 100 "Templifier" at a cost of $146,000. This $60,000 savings in the equipment cost might justify this alternative.

Heat pump compressor electricity and pumping electricity, from Table 5, totals 768,000 KWH per year. At $0.024 per KWH this amounts to $18,432 per year at the startup.

Based on previous studies, the maintenance cost is expected to be 4.14% of capital investment, and insurance costs to be 0.46% of capital investment.

Savings

The annual savings in natural gas purchase, from Table 5, is expected to be 98,400 therms per year. At $0.50 per therm this amounts to $42,200 per year at startup

Economic Analysis

The current annual cost of natural gas was established as $49,200. This annual cost was projected through the year 2000 at the following inflation rates:

1981-1984	7.6%
1985-1989	8.4%
1990-1994	10.3%
1995-2000	10.6%

Heat pump operation and pumping costs were estimated to be $18,432 per year. These costs were projected through the year 2000 at the following inflation rates:

1981-1988	8.9%
1989-2000	8.6%

Operation and maintenance costs were estimated to be 4.14% of the capital investment and these costs were projected at an inflation rate of 7% per annum through the year 2000, which is also the assumed economic inflation rate.

Insurance costs were estimated to be .46% of the capital investment and were projected to increase at 2% per annum over the 20-year project life.

Using these figures, the following table of projected cash flow was compiled:

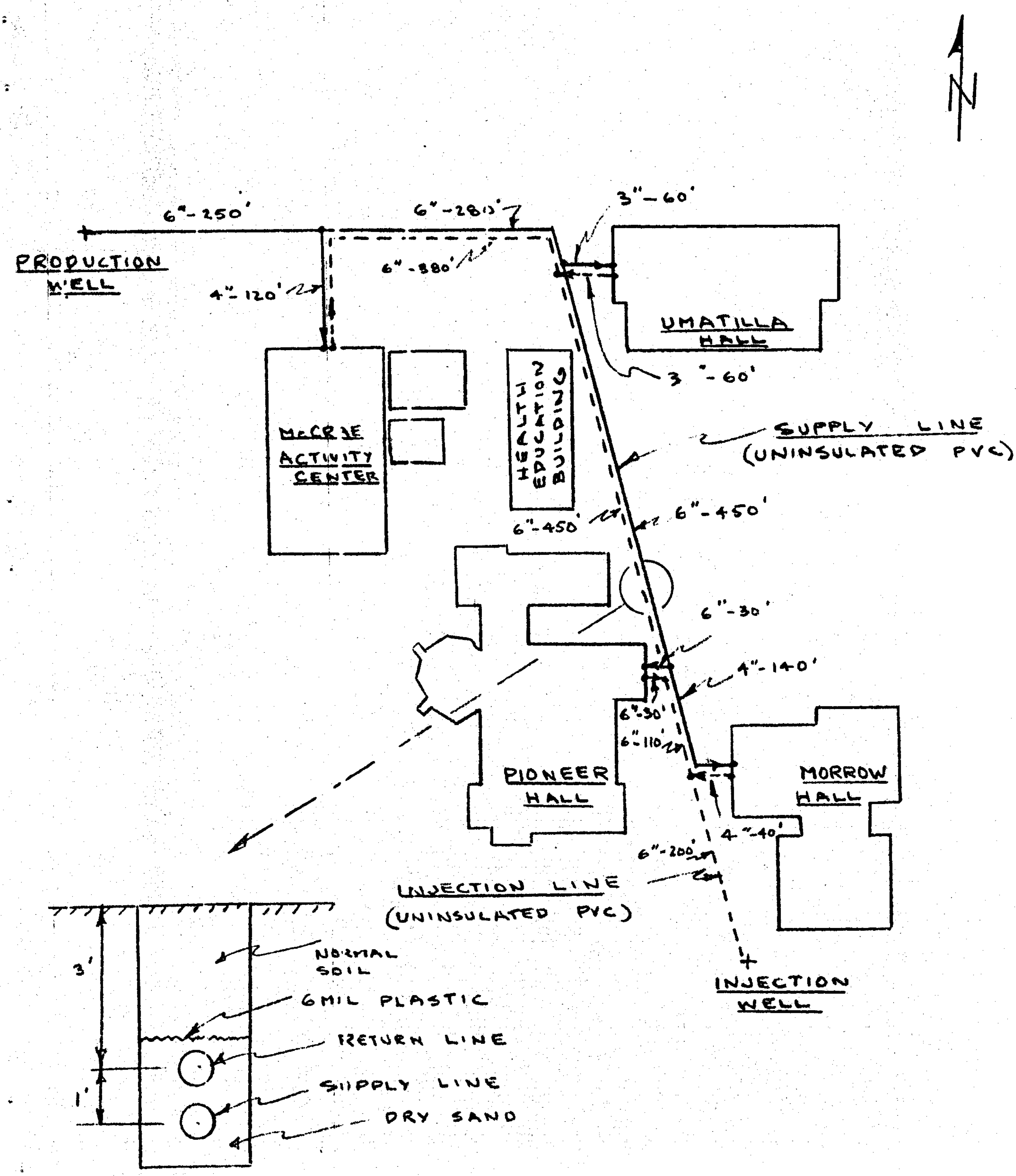
It was assumed that the college would finance the project with an 8% tax-free bond, maturing in 20 years. Based on these calculations, the college could afford to spend $367,500 for the project. Although the system appears to be marginally feasible, it should be understood that all inflation rates used were ultra-conservative and any actual increase in the cost of natural gas beyond our projections would make the project much more feasible. It is also likely that the system will last much longer than 20 years and the annual savings during this extended life will be in excess of $150,000 per year.

BLUE MOUNTAIN COMMUNITY COLLEGE
20-YEAR PROJECTION OF COSTS AND BENEFITS

20-Year Projected Cost Natural Gas	Geothermal System Electrical Cost	Geothermal System Maintenance Cost	Geothermal System Insurance Cost	20-Year Projected Cash Flow	Debt Service Annual Cost	Net Present Value at 8%
52939.	20072.	16279.	1724.	14862.	29400.	-13460.
56962.	21858.	17419.	1758.	15925.	29400.	-11551.
61291.	23804.	18638.	1793.	17055.	29400.	- 9799.
65949.	25922.	19943.	1829.	18254.	29400.	- 8192.
71489.	28230.	21339.	1866.	20054.	29400.	- 6360.
77494.	30742.	22832.	1903.	22015.	29400.	- 4653.
84004.	33478.	24431.	1941.	24152.	29400.	- 3061.
91060.	36458.	26141.	1980.	26480.	29400.	- 1577.
98709.	39593.	27971.	2020.	29124.	29400.	- 137.
108876.	42998.	29929.	2060.	33888.	29400.	2078.
120091.	46696.	32024.	2101.	39268.	29400.	4232.
132460.	50712.	34265.	2143.	45338.	29400.	6329.
146104.	55073.	36664.	2186.	52179.	29400.	8375.
161152.	59810.	39231.	2230.	59881.	29400.	10377.
178235.	64953.	41977.	2275.	69028.	29400.	12492.
197128.	70539.	44915.	2320.	79351.	29400.	14580.
218023.	76606.	48059.	2367.	90990.	29400.	16648.
241134.	83194.	51423.	2414.	104101.	29400.	18693.
266694.	90349.	55023.	2462.	118858.	29400.	20728.
294963.	98119.	58875.	2511.	135457.	396900.	-56092.
			TOTAL	1016269	TOTAL	- 351.

Appendix

FIGURE 2



TYPICAL BURIED PIPE

GPR 6/11/80

HEAT PUMP DUTY

TABLE 1

BUILDING	NO. OF UNITS	MODEL NO. (1)	PEAK DUTY BTU/HR x 10^6			EVAPORATOR WATER			CONDENSER WATER			COMPR. INPUT
			HEATING	HOT WATER	TOTAL	IN °F	OUT °F	GPM	IN °F	OUT °F	GPM	KWH
UMATILLA	1	TPB-055A	0.54	—	0.54	65	55	84.	120	130	110	47
McCREA/HEALTH	1	TPE-063A	1.66	0.63	2.29	65	52	250	120	130	463	200
PIONEER	1	TPE-063A	2.11	—	2.11	65	52	240	120	130	425	190
MORROW	1	TPB-060A	0.67	—	0.67	65	58	145	120	130	145	57
TOTAL	4	—	4.98	0.63	5.61	—	53.6	719	—	—	—	494

(1) WESTINGHOUSE "TEMPLIFIER"

GPR 6/12/80

METHOD OF HEAT UTILIZATION

TABLE 2

TYPE HEATER (E) = EXISTING (M) = MODIFIED (N) = NEW	BUILDING					TOTAL
	McCREA BTU/HR 10^6	HEALTH BTU/HR 10^6	UMATILLA BTU/HR 10^6	PIONEER BTU/HR 10^6	MORROW BTU/HR 10^6	
AIR HANDLER FINNED COILS (E)	—	—	—	0.341	—	0.341
AIR HANDLER FINNED COILS (M)	0.439	—	—	—	—	0.439
FINNED PREHEAT COILS (N)	0.381	—	—	—	—	0.381
REHEATER FINNED COILS (E)	0.130	—	—	0.719	0.459	1.308
FINNED DUCT COILS (E)	—	—	—	1.017	0.146	1.163
FINNED DUCT COILS (N)	0.540	0.170	0.440	—	—	1.150
UNIT HEATERS (E)	—	—	0.100	0.033	0.058	0.191
UNIT CONVECTORS (E)	—	—	—	—	0.007	0.007
PLATE HEAT EXCHANGER (N)	0.630	—	—	—	—	0.630
TOTAL	2.120	0.170	0.540	2.110	0.670	5.610

GPR 7/16/80

1978 ANNUAL ENERGY USAGE SUMMARY

BASIS: ENERGY AUDIT (1)

TABLE 3

BUILDING	AREA (FT²)	NATURAL GAS (2)			(3) ELECTRICITY (OIL REQ'D TO PRODUCE)				OVERALL EQUIVALENT OIL
		HEATING	HOT WATER	TOTAL	LIGHTING	COOLING	OTHER	TOTAL	
		BTU/YR x 10⁹	BTU/YR x 10⁹	BTU/YR x 10⁹	BTU/YR x 10⁹	BTU/YR x 10⁹	BTU/YR x 10⁹	BTU/YR x 10⁹	BTU/YR x 10⁹
UMATILLA	34,394	2.24	0.28	2.52	4.18	0.49	0.24	4.91	7.43
McCRAE	50,786	3.60 (4)	1.83 (5)	5.43 (4)	4.36 (4)	0.21 (4)	0.60 (4)	5.17 (4)	10.60 (4)
HEALTH	8,700	0.90 est.	0.20 est.	1.10	1.27 est.	0.23 est.	0.05 est.	1.55	2.65
PIONEER	59,906	5.40	1.53 (8)	6.93	7.07	1.36	0.61	9.04	15.97
MORROW	38,771	2.40	0.42	2.82	4.02	0.52	0.63	5.17	7.99
TOTAL	192,557	14.54	4.26	18.80 (6)	20.9	2.81	2.13	25.84 (7)	44.64

(1) KEITH KRUCHEK CONSULTING ENGINEERS, INC

(2) @ 1030 BTU/FT³ OR 97.087 FT³/THERM

(3) EQUIVALENT OIL REQUIRED TO GENERATE ELECTRICITY @ 11600 BTU/KWH

(4) ADJUSTED TO BALANCE 1978 GAS & ELECTRICITY PURCHASES.

(5) INCLUDES 0.99×10^9 TO HEAT SWIMMING POOL, AND 0.84×10^9 FOR HOT WATER FROM GENERATED STEAM.

(6) 18,231,053 ÷ 97 = 187949 THERMS/YR OR 18.80×10^9 BTU/YR

(7) 2227678 × 11600 = 25.84×10^9 BTU/YR

(8) INCLUDES 0.40×10^9 OF MISCELLANEOUS GAS USAGE

(9) est. = estimated

GPR 5/30/80

ESTIMATED ENERGY CONSUMPTION GOAL (1)

CONVENTIONAL FUEL

TABLE 4

BUILDING	AREA (FT^2)	NATURAL GAS (2)			ELECTRICITY (OIL REQ'D TO PRODUCE) (3)				OVERALL EQUIVALENT OIL
		HEATING	HOT WATER	TOTAL	LIGHTING	COOLING	OTHER	TOTAL	
		$BTU/YR \times 10^9$	$BTU/YR \times 10^9$	$BTU/YR \times 10^9$	$BTU/YR \times 10^9$	$BTU/YR \times 10^9$	$BTU/YR \times 10^9$	$BTU/YR \times 10^9$	$BTU/YR \times 10^9$
UMATILLA	34,394	0.87	0.28	1.15	3.99	0.49	0.24	4.72	5.87
McCRAE	50,786	2.42	(4) 1.76	4.18	4.31	0.21	0.48	5.00	9.18
HEALTH	8,700	.28	.20	.48	1.20	0.23	0.05	1.48	1.96
PIONEER	59,906	3.42	(5) 1.30	4.72	5.22	1.27	0.61	7.10	11.82
MORROW	38,771	1.09	0.41	1.50	3.40	0.52	0.62	4.54	6.04
TOTAL	192,557	8.08	3.95	12.03	18.12	2.72	2.00	22.84	34.87

(1) INTERPRETATED FROM USAGES FORCAST AFTER IMPLEMENTATION OF OPERATING AND MAINTENANCE ITEMS. ENERGY AUDIT BY KEITH KRUCHEK, CONSULTING ENGINEERS, INC.

(2) @ 1030 BTU/FT^3 OR 97.087 FT^3/THERM

(3) EQUIVALENT OIL REQUIRED TO GENERATE ELECTRICITY @ 11600 BTU/KWH

(4) INCLUDES 0.92×10^9 TO HEAT SWIMMING POOL, AND 0.84×10^9 FOR HOT WATER FROM GENERATED STEAM.

(5) INCLUDES 0.40×10^9 OF MISCELLANEOUS GAS USAGE

GPR 5/30/80

ENERGY CONSUMPTION COMPARISON

TABLE 5

BUILDING	NATURAL GAS				ELECTRICITY					OVERALL CONSUMP.
	HEATING	HOT WATER	TOTAL		LIGHTING	COOLING	OTHER	TOTAL		
	BTU/YR $\times 10^9$	BTU/YR $\times 10^9$	BTU/YR $\times 10^9$	THERMS/YR	BTU/YR $\times 10^9$	BTU/YR $\times 10^9$	BTU/YR $\times 10^9$	BTU/YR $\times 10^9$	KWH	BTU/YR $\times 10^9$
EXISTING SYSTEM										
UMATILLA	0.87	0.28	1.15	11500	1.17	0.14	0.07	1.38	404000	2.53
McCRAE	2.42	1.76	4.18	41800	1.27	0.06	0.14	1.47	431000	5.65
HEALTH	0.28	0.20	0.48	4800	0.36	0.07	0.02	0.45	132000	0.93
PIONEER	3.42	1.30	4.72	47200	1.53	0.38	0.18	2.09	612000	6.81
MORROW	1.09	0.41	1.50	15000	1.00	0.15	0.18	1.33	390000	2.83
TOTAL	8.08	3.95	12.03	120300	5.33	0.80	0.59	6.72	1969000	18.75
PROPOSED SYSTEM										
UMATILLA	0	0.28	0.28	2800	1.17	0.14	0.30	1.61	472000	1.89
McCRAE	0	0	0	0	1.27	0.06	1.26	2.59	759000	2.59
HEALTH	0	0.20	0.20	2000	0.36	0.07	0.09	0.52	152000	0.72
PIONEER	0	1.30	1.30	13000	1.53	0.38	1.09	3.00	879000	4.30
MORROW	0	0.41	0.41	4100	1.00	0.15	0.47	1.62	475000	2.03
TOTAL	0	2.19	2.19	21900	5.33	0.80	(1) 3.21	9.34	2737000	11.53
DECREASE (INCREASE)	8.08	1.76	9.84	98400	0	0	(2.62)	(2.62)	(768000)	7.22

(1) EXISTING PLUS 1/3 OF HEATING DUTY AT 80% EFFICIENCY.

GPR 6/2/80

(5)

SUMMARY OF WORK AT McCREA

1. REMOVE EXISTING PREHEAT COIL
2. INSTALL NEW 21" FIN HT x 60" FIN LENGTH FINNED PREHEAT COIL DIAGONALLY IN EXISTING 24"x57" DUCT.
3. INSTALL NEW 50" FIN HT x 72" FIN LENGTH FINNED COIL IN 54"x72" DUCT IMMEDIATELY ADJACENT TO ATTENUATOR.
4. CONNECT NEW PREHEAT COIL IN SERIES AND DOWNSTREAM FROM WATER LEAVING COIL IN ATTENUATOR DUCT
5. CONVERT AIR HANDLER COILS FROM STEAM TO WATER BY INCREASING NUMBER OF FEEDS.
6. USE EXISTING REHEAT COILS WITHOUT MODIFICATION
7. INSTALL PLATE HEAT EXCHANGER FOR POOL HEAT & DOMESTIC HOT WATER
8. INSTALL HEAT PUMP
9. CONNECT WELL WATER
10. INSTALL CIRCULATING HOT WATER PIPING TO & FROM HEAT PUMP
11. CONTROLS & ELECTRICAL HOOK UPS

McCREA

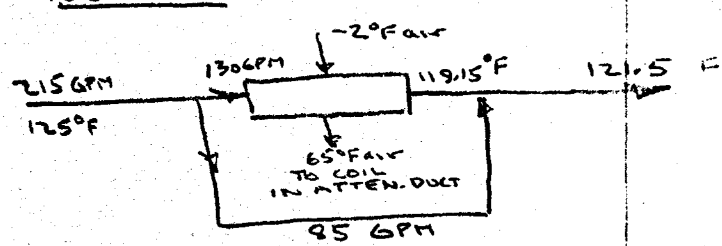
ESTIMATED CAPACITY EXISTING AIR HANDLING UNITS CONVERTED TO 130°F WATER.

	AHU#1		AHU #2		AHU # 3	
EA	48.4	65	48.4	65	48.4	65
LA	70	81.6	69.7	81.6	69.6	81.5
EW	130	130	130	130	130	130
LW	120	120	120	120	120	120
CFM	4300	4300	6425	6425	1885	1885
FA	6.74	6.74	13.11	13.11	3.88	3.88
# FEEDS (AFTER MODIFICATION)	5	5	6	6	2	2
ELEV	1492	1492	1492	1492	1492	1492
ROWS	1	1	1	1	1	1
TUBE/ROW	17	17	17	17	11	11
FPI	10	10	8	8	8	8
ΔP "WC	.15	.14	.08	.08	.08	.08
PASSES	3.4	3.4	2.83	2.83	5.5	5.5
ΔP 'WC	2.62	1.56	5.15	3.13	3.53	2.14
GPM	19.89	14.87	29.44	22.22	8.60	6.40
GPM/FEED	3.978	2.97	4.91	3.70	4.30	3.20
BTU/HR (EACH)	99431	74357	147214	111103	42988	32400
# UNITS	2	2	4	4	1	1
TOTAL AVAIL. BTU/HR	198862	148714	588856	444412	42988	32400
% RECYCLE	75	100	75	100	75	100
% O.A	25	0	25	0	25	0

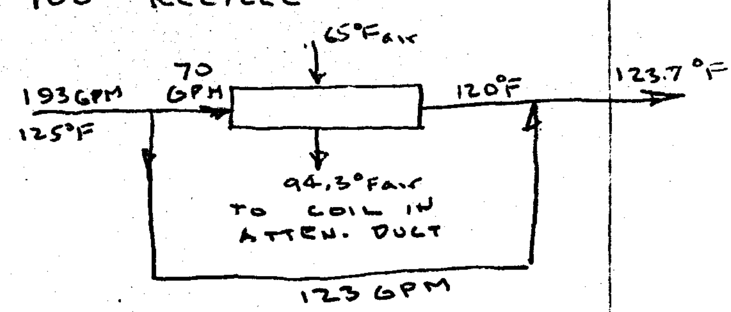
REPLACE PREHEAT COIL McCREA.
INSTALL NEW 21" FIN HT x 57" FIN LG. DIAGONALLY IN EXISTING 24" x 57" DUCT.

EA	-2	65
LA	65	94.3
EW	125	125
LW	119.15	120.0
CFM	5454	5454
FA	8.75	8.75
# FEED	26	26
ELEV	1492	1492
ROW	2	2
TUBE/ROW	13	13
FPI	10	10
ΔP in. WC	.26	.27
PASSES	1	1
ΔP ft WC	4.21	2.49
GPM	130.2	69.7
GPM/FEED	5.01	2.69
BTU/HR	380658	174184
AFM	623	623
% RECYCLE	0	100
% OA.	100	0

100% OA



100% RECYCLE



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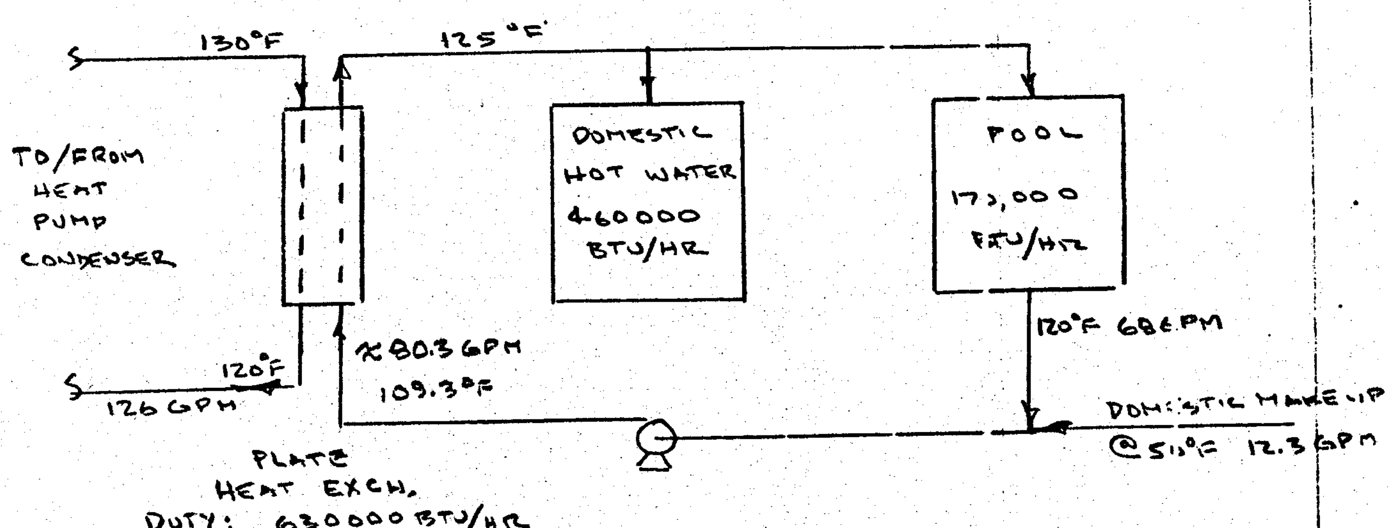
© INSTALL FINNED COIL IN ATTENUATOR DUCT – McCREA

4½' x 6' DUCT   50" FIN HT x 72" FIN LENGTH

EA	65	70.85
LA	84	88
EW	130	130
LW	125	125
CFM	27272	27272
FA	25	25
# FEEDS	64	64
ELEV	1492	1492
ROWS	2	2
TUBE/ROW	32	32
FPI	6	6
ΔP mWC	.45	.44
PASSES	1	1
ΔP ft WC	8.40	6.87
GPM	215	193
GPM/FEED	3.37	3.01
BTU/HR	539778	481851
AFM	1091	1091

PREHEATED AIR @	65 °F	94.3 °F

McCREA – HOT WATER



(D)

McCREA – ESTIMATE CAPACITY OF EXISTING ELEVEN (11) REHEAT COILS

	SIMULATED EXISTING AVERAGE COIL (EXIST. CONDITIONS)	SIMULATED EXISTING AVERAGE COIL (PROPOSED CONDITIONS)	
EA	70	84	94.3
LA	85.6	90.1	98.8
EW	200	130	130
LW	156	120	120
CFM	1927	1927	1927
FA	3.58	3.58	3.58
#FEEDS	1	1	1
ELEV	1492	1492	1492
ROWS	1	1	1
TUBE/ROW	7	7	7
FPI	3.63	3.63	3.63
ΔP"WC	.05	.05	.05
PASSES	7	7	7
ΔP'WC	.68	1.90	1.09
GPM	1.41	2.36	1.71
GPM/FEED	1.41	2.36	1.71
BTU/HR (EACH)	30986	1181[illegible]	8556
NO. UNITS	11	11	11
BTU/HR (TOTAL)	340850	129988	94117

HEALTH / EDUCATION
SUMMARY

1. MODIFY EACH HOT AIR SUPPLY DUCT TO INSTALL A FINNED COIL IN EACH OF TWO (2) DUCTS.
2. INSTALL HOT WATER CIRC. PIPING FROM McCREA
3. CONTROL VALVES & ELECTRICAL

EA	65
LA	98.8
EW	130
LW	120
CFM	2446
FA	3.13
#FEEDS	4
ELEV	1492
ROWS	2
TUBE/ROW	9
FPI	13
ΔP"WC	.47
PASSES	4.5
ΔP'WC	3.26
GPM	17.22
BTU/HR (EACH)	86122
NO. UNITS	2
BTU/HR TOTAL	172244

(E)

UMATILLA

SUMMARY

(1) INSTALL HEAT PUMP & RELATED PIPING

(2) INSTALL SEVEN (7) FINNED COILS IN SUCTION DUCT AT EACH FAN IN DUCT HEATER UNITS.

(3) INSTALL CIRCULATION PIPING TO SERVE NEW COILS (7) AND EXISTING CLASS ROOM HEATING FACILITIES.

(4) CONTROLS & ELECTRICAL (ALLOW FOR FIRING OF DUCT HEATERS DURING COLDEST CONDITIONS)

COIL NO.	CFM	GPM	BTU/HR	FA (1)	TUBE/ROW	ROW	FPI	FEEDS	EA/LA	ΔP "WG	ΔP FINC.
1	8000	18.2	91168	11.38	12	1	6	4	65/77.7	.09	4.68
2	4000	9.1	45584	5.94	9	1	6	2	65/77.7	.08	4.03
3	5000	11.4	56980	7.19	9	1	6	2	65/77.7	.09	8.29
4	14210	32.4	161937	19.69	14	1	6	7	65/77.7	.09	5.57
5	2200	5.0	25071	3.25	12	1	6	1	65/77.7	.08	8.62
6	1700	3.9	19373	3.06	13	1	6	1	65/77.7	.04	6.52
7	3500	8.0	39887	5.16	10	1	6	2	65/77.7	.05	3.57
TOTAL SHOP	38610 @130° =	88.0	440,000	55.67							

EXIST. CLASSROOM 100,000

TOTAL 540,000

(1) DIAGONAL INSTALLATION

(F)

PIONEER

SUMMARY

1. INSTALL HEAT PUMP & RELATED PIPING
2. PIPE HOT WATER TO UNIT HEATERS, AIR HANDLER, REHEAT COILS, & EXISTING COOLING COIL IN SUCTION DUCT TO FA S-1.
3. REVISE PIPING TO PERMIT USE OF COOLING COIL FOR HOT/COLD.
4. CONTROLS & ELECTRICAL

	AIR HANDLER				REHEAT COILS (AVG. OF 54 UNITS)				
	EXIST. SERVICE		REVISED SERVICE		EXIST. SERVICE		REVISED SERVICE		
EA	55	65	55	65	50 (a.A)	65	50	65	77
LA	100	107	78	94	110.6	19.6	81.6	90	96.4
EW	200	→	130	130	200	→	130	→	→
LW	180	→	120	120	180	→	120	→	→
CFM	14470	→	→	→	674	→	→	→	→
FA	21.87	→	→	→	.9 (est)	→	→	→	→
# FEED	19	→	→	→	2 (est)	→	→	→	→
ELEV	1492	→	→	→	1492	→	→	→	→
ROW	1	→	→	→	2 (est)	→	→	→	→
TUBE/ROW	19	→	→	→	6 (est)	→	→	→	→
FPI	13	13	13	13	8 (est)	→	→	→	→
DP"WC	.19	.19	.19	.19	.28	.27	.28	.27	.26
PASS	1	→	→	→	6	→	→	→	→
ΔP'WC	2.63	2.25	3.19	3.50	.68	.53	.85	.53	.33
BTU/HR(EA)	69.15	63.81	70.68	57.28	4.33	3.83	4.57	3.51	2.66
GPM	691477	633085	353421	286396	43719	38335	22839	17553	1331
GPM/FEED	3.64	3.33	3.72	3.01	2.19	1.92	2.28	1.75	1.33
FPM	660	662	661	661	702	→	→	→	→
NO. UNITS	1	→	→	→	54	→	→	→	→
BTU/HR (TOTAL)	691477	633085	353421	286396	2365,142	2,070,090	1,233,305	947,862	719,11
% RECYCLE	85	100	85	100	78	100	78	100	PREHEAT FROM COOLING COIL
% OA	15	0	15	0	22.	0	22.	22	

(6) PIONEER

CONVERT EXISTING COOLING COIL TO HOT WATER.

	AS COOLING COIL	CONVERTED TO HEATING COIL	
EA	84.3 (DB) 64.5 (WB)	55	65
LA	55.0 (DB) 51.7 WB	77	104.5
EW	42	130	
LW	52	120	
CFM	43510	→	→
FA	75	→	→
# FEED	360	→	→
ELEV	1492	→	→
ROW	6	→	→
TUBE/ROW	60 est	→	→
FPI	10	→	→
ΔP "WC	.69	.69	.68
PASS	1	→	→
ΔP 'WC	14.75	7.14	19.48
BTU/HR (EA)	(1) 1,353,796	1,016,502	1,790,604
GPM	270.8	203.3	284.6
GPM/FEED	.75	.56	.79
FPM	580	580	580
% RECYCLE	—	82	100
% OA	—	18	0

(1) DRY COIL

(H) MORROW

SUMMARY

① INSTALL HEAT PUMP & RELATED PIPING
② CONVERT EXISTING HOT WATER PIPING
③ CONTROLS & ELECTRICAL

CAPACITY EXISTING MULTIZONE HEATING

	EXISTING FROM SPECS	EXISTING WITH ASSUMPTIONS	EXISTING REVISED CONDITIONS	
EA	50 →	→	50	65
LA	80 →	→	73	33
EW	200 →	→	130 →	→
LW	180 →	→	120 →	→
CFM	1500 @ 70°F	1520 →	→	→
FA	2.25 →	→	→	→
# FEED	—	2.5 →	→	→
ELEV	—	1492 →	→	→
ROW	—	1 →	→	→
TUBE/ROW	—	5 →	→	→
FPI	—	7.42/13	12.51/13	1.51/13
ΔP "WC	.275	0.20	0.20	0.19
PASS	—	2 →	→	→
ΔP 'WC	.400	.32	0.80	0.49
BTU/HR	—	48,899	37,489	23,501
GPM	5	4.89	7.50	5.70
GPM/FEED	—	.98	3.00	2.28
FPM	675	675 →	→	→
% RECYCLE	—	—	78	00
% OA	—	—	22	0

	EST. TOTAL CAPACITY EXISTING COND. BTU/HR	EST. TOTAL CAPACITY REVISED COND. BTU/HR	
UNIT CONVECTORS	16400	7036	7035
UNIT HEATERS	135500	58130	58130
UNIT VENTILATORS	1521000	652509 }	910489
UNIT VENTILATORS (6)	601353	257980 }	
FAN COIL	273600	117379 }	145875
MULTIZONE COIL	48899	28501 }	
	2,596,702		1,121,529

AVAILABLE EXISTING COILS 1,121,529 BTU/H

REQUIRED " " 670,000 BTU/H