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WIPP Conceptual Design Report

Addendum F: **HVAC Systems Energy Analysis for Waste Isolation Pilot Plant (WIPP) Conceptual Design Report, By Holmes & Narver, Inc., Anaheim, California, April 1977**

Prepared by Sandia Laboratories, Albuquerque New Mexico 87115 and Livermore, California 94550 for the United States Energy Research and Development Administration under Contract AT (29-1)-789

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ADDENDUM F

HVAC Systems Energy Analysis

For a

WASTE ISOLATION PILOT PLANT

April 1977

Submitted To

FENIX & SCISSON, INC.

TULSA, OKLAHOMA

HOLMES & NARVER, INC.
ENGINEERS—CONSTRUCTORS

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CONTENTS

*Appendix C is printed separately and is not normally distributed with this addendum. The information in this Appendix, which is approximately 600 pages of computer printout, is summarized in the HVAC energy study. Interested persons should consider this fact before requesting a copy of this lengthy Appendix.

1. SUMMARY AND RECOMMENDATIONS

1.1 SUMMARY

This report presents the results of a technical and economic analysis of alternative methods of meeting the heating, ventilating, and air-conditioning requirements of the Waste Isolation Pilot Plant (WIPP) facilities proposed to be constructed in southeastern New Mexico.

This report analyzes a total of ten WIPP structures to determine the most energy and economic efficient means of providing heating, ventilating, and air-conditioning services. Additional analysis was performed to determine the merits of centralized versus dispersed refrigeration and heating facilities, and of performing supplemental domestic hot water heating with Solar panels.

HVAC systems for several of the major WIPP structures, representing in excess of 85 percent of the site HVAC energy demand, were examined in detail utilizing the Trane Company "TRACE" computer program. The buildings analyzed were the Administration, RH Waste, TRU Waste and Man/Material structures. Each was analyzed for several alternative HVAC systems dependent upon the primary functional requirements of the HVAC system for the particular building. Waste handling building systems utilize once-through ventilation while the Adminstration facility is an office-type facility using more conventional type air-conditioning. In addition to the basic HVAC systems, several energy conservation techniques such as heat recovery for one-through systems, solar assist, and supplemental evaporative cooling were considered. The acceptability of these energy conservation additions was assessed by the determination of life-cycle costs using the LIFCY1 computer program.

The systems found to be most energy effective for the WIPP Facility were:

Administration: Medium pressure variable air volume system with internal heat recovery, utilizing supplemental evaporative cooling and a solar assisted, electrically driven heat pump.

RH Waste: Once through ventilation system with heat recovery from exhaust air flow, utilizing supplemental evaporative cooling and solar assisted electrically driven heat pump for the air-conditioning.

TRU Waste: Once through ventilation system with heat recovery from exhaust air flow, utilizing supplemental evaporative cooling and solar assisted electrically driven heat pump for the air-conditioning.

Man/Materials: A multi-zone system using evaporative cooling and heat recovery. Hot water heating for this facility will be supplemented by solar heating units.

The TRACE and LIFCYI program results were then taken into account in the evaluation of the remaining WIPP buildings to determine the HVAC systems to be recommended for use. The systems recommended for these buildings are as follows:

Site Entrance Gate House - an electrically driven heat pump will provide heating and cooling.

Warehouse/Shops - a multi-zone system using evaporative cooling will serve the office area. A once through system with evaporative cooling and spot heating will serve the shop area.

Vehicle Maintenance - spot heating will be provided in the maintenance area. The office and toilet area will be ventilated with cooling by an evaporative cooler and heating by resistance heating elements.

Suspect Waste/Laundry - a once-through system will utilize zoned pressure control and HEPA exhaust filters. Evaporative cooling, resistance heating and heat recovery will be used in the system.

RH-TRU Hoist House - a once-through system with evaporative cooling and resistance heating will be utilized.

2. BACKGROUND AND PURPOSE OF REPORT

In recent years attention has been focused on energy as an exhaustible resource. The growing realization that energy supplies are dwindling and

the pressure of an expanding energy demand has resulted in a conscious effort to curtail inefficient energy use. In keeping with the need to make the best possible use of energy resources, it has become increasingly desirable to assure efficient methods of heating, cooling, and ventilating buildings. This report presents the results of analysis directed at assuring an energy efficient design basis for the WIPP Facility HVAC systems.

Basic activities of the HVAC energy analysis were as follows:

1. Gather data on building HVAC requirements, including allowable temperatures and building configurations.

2. Determine building ventilation requirements and resulting concepts.

3. Analyze the HVAC concepts to determine technical and economic acceptability.

4. Report the resulting conclusions and recommendations.

3. DEVELOPMENT OF DATA

Data and material utilized in the performance of the HVAC energy study was gathered over the period from the project initiation in June, 1976 to the completion of the analysis in April, 1977. During this period numerous meetings were held with representatives of Sandia Laboratories, Fenix & Scisson, Inc., and Holmes & Narver, Inc., in attendance. As design of the WIPP evolved, the philosophy of the HVAC requirements evolved in a parallel process. The evolution resulted in the development of facility designs requiring analysis of the economic and energy utilization alternatives. The following methods were utilized in the analysis:

- The basic mechanical HVAC systems concept was based on conformance with General Design Criteria for Interior Mechanical Systems, Part 1, Section D, ERDA Appendix 6301; ASHRAE Standard 90-75, and NRC Guides.

- The heat load calculations were performed in accordance with the ASHRAE Handbook of Fundamentals.

- Life cycle studies were performed in accordance with ERDAM 6301 Interim Life-Cycle Costing Guidelines.

- Total annual energy useages were determined by use of "TRACE" computer programs for major facility structures.

- Relative energy conservation and payoff times of various alternative systems were determined by use of Sandia Laboratory LIFCYL computer programs.

4. HVAC SYSTEM ALTERNATIVES ANALYZED

A total of 6 "TRACE" computer runs were made in the examination of the HVAC systems for the four major WIPP structures. In addition, a number of LIFCYL runs were performed to determine the life cycle costs of various alternative systems being considered for WIPP. Data from the "TRACE" and LIFCYL runs was then utilized in making decisions on HVAC system configurations for buildings which were not analyzed with the "TRACE" program. Table 4-1 presents a summary of the alternatives considered in the "TRACE" computer analysis. Copies of the "TRACE" computer runs are incorporated as an appendix to this report. As a result of the "TRACE" runs, the following systems were selected as the most favored for the four major WIPP buildings.

Administration Facility: Medium pressure variable air volume system utilizing reciprocating heat pump with heat recovery, supplemental evaporative cooling, and supplemental solar panels.

RH Waste Facility: 100% outside air, heat recovery with a centrifugal heat pump, supplemental evaporative cooling, and supplemental solar panels.

TRU Waste Facility: 100% outside air, heat recovery with a centrifugal heat pump, supplemental evaporative cooling, and supplemental solar panels.

Man/Materials Building: Packaged roof top multizone unit using 100% outside air with heat recovery, resistance heating, supplemental evaporative cooling, and supplemental solar panels.

TABLE 4-1

SUMMARY OF WIPP HVAC ALTERNATIVES

BUILDING	ALTERNATE 1	ALTERNATE 2	ALTERNATE 3	ALTERNATE 4
ADMINISTRATION RUN 1	Centrifugal heat pump Double duct	2 stage absorption – district steam double duct	2 stage absorption – district steam variable air volume	Centrifugal heat pump Variable air volume
ADMINISTRATION RUN 2	District chilled water District steam Double duct	District chilled water District steam Variable air volume	Reciprocating chiller/ heat pump Variable air volume	Reciprocating chiller/ heat pump Double duct
ADMINISTRATION RUN 3	System 1 – variable air volume – reheat – runs 24 hrs/day – no cafeteria System 2 – variable air volume – reheat – night shutdown. Centrifugal chiller – 105°F condenser water	System 1 – variable air volume – reheat – runs 24 hrs/day – no cafeteria System 2 – variable air volume – reheat – night shutdown Centrifugal chiller 105°F condenser water. Chiller shutdown below 77°F D.B. for evap. cooling	Same as alternate 1 but uses reciprocating chiller	Same as alternate 2 but * uses reciprocating chiller
RH	Centrifugal heat pump District steam Heat recovery 100% outside air	Centrifugal heat pump * District steam Heat recovery 100% outside air Heat pump shutdown below 77°F D.B. for evap. cooling	Same as alternate 1 but uses centrifugal refrigeration	Same as alternate 2 but uses centrifugal refrigeration
TRU	Centrifugal refrigeration District steam heat 100% outside air	Centrifugal heat pump District steam heat 100% outside air	Centrifugal heat pump District steam heat Heat recovery 100% outside air	Centrifugal heat pump * District steam heat Heat recovery 100% outside air Centrifugal heat pump off below 77°F for evap. cooling
MAN/MATERIALS	Packaged roof top multizone; resistance heating; 100% outside air No heat recovery. No refrigeration below 77°F D.B. for evap. cooling	Packaged roof top multizone; * resistance heating; 100% outside air. Heat recovery. No refrigeration below 77°F D.B. for evap. cooling	Same as alternate 1, except refrigeration below 77°F D.B. is continued on all areas but change room	Same as alternate 2 except refrigeration below 77°F D.B. is continued on all areas but change room

Note: *denotes sytem selected.

Following selection of the basic systems, the addition of supplemental energy conservation techniques was considered. The conservation techniques considered were:

Heat pipes & liquid transfer heat recovery

Solar assist for space heating

Evaporative cooling

Solar assist for hot water heating

The relative merit of the supplemental systems was determined on the basis of cost effectiveness as determined by LIFCYL computer program analysis. Specifics of the LIFCYL analysis are reported in Section 5 of this report.

On the basis of the analysis leading to the preceeding conclusions, HVAC systems have been selected for the remainder of the WIPP facilities. The remaining buildings are not of the type nor do they have the use and occupancy factors which will require complete air conditioning and heating, and therefore did not require as complete an analysis as the major structures referenced above. Listed below are the WIPP facilities and the HVAC systems recommended for each.

Gate House - No specific analysis has been performed for this structure. Heating and cooling will be provided by an electric heat pump unit. As noted in the architectural description for the building, insulation will be provided to meet required "U" values.

Mine Filter Building - Air passing through this building will be at a relatively constant temperature. Due to its heavy concrete walls, the interior of the building will remain at a relatively constant temperature throughout the yearly period. Mine ventilation fans will be connected to the vital power supply system assuring continued airflow through the building. No internal heating or cooling is anticipated, therefore, no energy analysis was performed.

Vehicle Maintenance Facility - Electric resistance spot heating will be provided for this building as required for personnel and freeze protection. The building will be open to the outside and air conditioning

is not recommended. Evaporative cooling will be utilized for the small office and restroom area.

Suspect Waste/Laundry Building - Due to the presence of radioactive liquids and the possibility of radioactive vapors in this building, a once through ventilation system without reheat will be utilized. Evaporative cooling and only minor resistance heating will provide sufficient heating and cooling for the building. No specific energy analysis has been performed for this building. Laundry activities will provide an internal source of heat for the building. Laundry operations will occur during the daytime, not at night, and spot radiant heaters will be provided for freeze protection. Solar hot water heating will be utilized for meeting laundry requirements.

Hoist Houses - The RH and TRU hoist house rooms will be connected via cable tunnels to their respective waste handling building. Ventilation air entering each room will pass through the motor and control area to remove heat generated during hoisting operations and a portion will be exhausted. The remainder of the air will be drawn through the cable tunnels and into the waste handling buildings, assuring positive control of radioactive contamination should it be carried on the cable. Hoist operator control rooms in both buildings will be heated and cooled by small self-contained units.

The Man/Materials hoist house will be heated as required by spot heating with no cooling being provided. The operator control room will be heated and cooled by small, self-contained heat pump units.

Emergency Generator Building - This structure is designed to resist tornado missiles and therefore it has heavy concrete walls providing good insulating qualities. The building has a low population factor; local heating will provide personnel comfort when the building is occupied. Ventilation will be required for standby generator heat removal when the generators are in operation and will be provided as an integral part of the building design. This building did not justify a complete and comprehensive

energy analysis.

Warehouse/Shops - The warehouse building contains storage space, office space, and shop areas. Cooling will not be provided for the storage area. Spot heating will be provided for freeze protection. The shops will be provided with a once through ventilation system to assure acceptable air quality. Evaporative cooling will be utilized when required, spot heating will provide heat on an "as required" basis. Estimated heating and cooling loads for the WIPP service buildings are summarized in Table 4-2. These loads were prepared by Holmes & Narver, Inc. for use in the Alternative Energy Sources analysis performed by Envirodyne Energy Services. They are indicative of the building loads which should be anticipated and provide a source for comparison of their magnitude relative to the loads established for the major WIPP buildings.

5. LIFE CYCLE COSTS

As mentioned in prior sections, the LIFCY1 program was utilized to determine the relative merits of alternate HVAC systems. Copies of the input and output for the runs performed are included in the Appendix of this report. Table 5-1 summariezes the results of the runs and presents conclusions based on those results. For the purposes of life cycle cost analysis, the district steam heating loads computed in the TRACE runs were converted to electrical power demand.

TABLE 4-2

ESTIMATED WIPP SERVICE BUILDING HVAC LOADS

BUILDING	DESIGN LOAD PEAK		ANNUAL LOADS	
	HEATING BTU/HR	EVAPORATIVE COOLING HP-KW	HEATING KWHRS	COOLING KWHRS
Warehouse/Shops	519,000	17 HP	89,000	2,160
Vehicle Maintenance Facility	86,400	15 HP	43,300	432
Emergency Power Building	96,000	15 HP	49,400	1,296
Hoist Houses	34,100	3 HP	40	29
Suspect Waste/Laundry Building	144,000	15 HP	24,700	432
Site Entry Gatehouse	30,000	3 HP	15,400	31,000

TABLE 5-1

SUMMARY OF LIFCYI ANALYSIS RESULTS

Building	System	Payback Period, Years	Savings/Investment Ratio
RH - 1	Heat Recovery	7.2	3.064
RH - 2	Evaporative Cooling	3.5	5.955
RH - 3	Solar Assist	18.3	1.321
TRU - 1	Heat Recovery	8.2	2.758
TRU - 2	Evaporative Cooling	3.5	5.975
TRU - 3	Solar Assist	18.5	1.308
Administration	Evaporative Cooling	3.3	6.279
Administration	Solar Assist	15.5	1.534
Laundry	Solar Assist for Hot Water	12.3	1.906

6. CONCLUSIONS

Conclusions have been described in the development of the body of the report and are summarized here:

A. A Central Heating and Refrigeration plant is uneconomic for the WIPP facility when compared to individual systems located in the buildings they serve.

B. Evaporative cooling is an economic supplement to heat pump refrigeration systems. In addition, evaporative cooling is an economic means of providing cooling for minor buildings at a facility with a design interior temperature of 82° F.

C. Solar assist for space and hot water heating is economic for the WIPP facility.

D. Heat pipes and liquid transfer heat recovery are an economic supplement for once through ventilation systems.

E. For conventional air conditioning systems, a variable air volume system is the favored alternate.

APPENDIX A

AN ANALYSIS OF

CENTRAL HEATING/REFRIGERATION

VERSUS

INDIVIDUAL HEAT PUMPS

SUMMARY

In accordance with WIPP project criteria H&N has evaluated the use of individual heat pumps versus a central steam/chilled water plant for the WIPP facility buildings requiring refrigeration. This evaluation shows that individual heat pumps are the most desirable from both energy and economic viewpoints.

DISCUSSION

Three of the WIPP buildings will require refrigeration and heating which could be supplied from either a central heating/cooling plant or from individual heat pumps. These are the TRU, RH and Administration buildings. Three alternate systems, listed below, have been considered for supplying the heating and cooling requirements for these buildings.

Alternate 1 - Central Refrigeration plus Steam Boilers with chilled water and steam piping to buildings (RH - TRU - Administration).

Alternate 2 - Individual Heat Pumps and cooling towers in each building (RH - TRU - Administration).

Alternate 3 - Individual Heat Pumps with a central cooling tower and condenser water piping to the buildings (RH - TRU - Administration).

The attached cost estimate shows the relative initial costs of the three alternates. The costs overwhelmingly favor the use of Alternate 2 - individual heat pumps and cooling towers at each building. The operating costs, including energy, will also favor the use of individual systems. Alternate 1 will have high thermal losses in the piping network and will require the operation and maintenance of a large central system whenever any of the buildings require services. Alternate 1 is also less energy efficient because the central system cannot be operated as a heat pump. Comparison of the energy consumption of a central system (Alternate 1) versus individual systems (Alternate 2) shows the advantages of individual systems on an annual energy consumption basis.

Individual Systems	3,810,000 KWH/YR
Central Plant	4,190,000 KWH/YR + 11,148 Therms

CONCLUSION

On the basis of initial economics and estimated energy consumption, it is recommended that individual heat pumps be utilized to provide heating and cooling for the RH, TRU and Administration buildings.

SUMMARY ESTIMATE SHEET

HOLMES & NARVER, INC.
ENGINEERS - CONSTRUCTORS

ACTION PERIOD EXTENSIONS: BY: WD C DATE: 3-15-77 L CHECKED DATE

ACCT NO	DESCRIPTION	MAN-HOURS	LABOR	MATERIAL	SUB-CONTRACT	TOTAL
	ALTERNATE 1	6468	226 380	338 500	150 000	714 880
	ALTERNATE 2	700	24 500	217 900	23 800	266 200
	ALTERNATE 3	3324	116 340	320 860	36 500	473 200
	NOTE: ABOVE ARE DIRECT COST NO MARKUP ON INDIRECTS					
	TOTAL					

FACILITY WASTE ISOLATION PILOT PLANT LOCATION

OWNER AREA S F COST

TYPE OF ESTIMAT EST STUDY JOB NO. 8251.10 SHT NO 1 OF 4 BID ITEM NO.

EE-30 OCT 70 REV

DETAIL ESTIMATE SHEET

HOLMES & NARVER INC.
ENGINEERS - CONSTRUCTORS

ACTION	BY	DATE	CHECKED	DATE
PRICED	MW	3-15-77		
EXTENSIONS	C			

ACCT. NO.	DESCRIPTION	QUANTITY	UNIT	LABOR				MATERIAL		SUBCONTRACTS		TOTAL COST
				LABOR UNIT	TOTAL MHRS	RATE HR.	AMOUNT	COST UNIT	AMOUNT	COST UNIT	AMOUNT	
	ALTERNATE I											
	300 TON CHILLER	3	EA		300				111 000			
	300 " COOLING TOWER	3	|		0						17 500	
	40HP CIRC PUMPS	6	|		120				9000			
	5000#/HR BOILER	2	|		300				99 500			
	CONVERTORS	3	|		60				4500			
	PIPE-VALVE FTGS IN BUILDING	4%			1500				15 000			
	DISTRIBUTION PIPE											
	8" ϕ STL. PIPE INSULATED	3720	LF		2250				83 500			
	6" ϕ " "	1860	|		750				37 500			
	4" ϕ " "	1860	|		600				33 600			
	TRENCH & BACKFILL 5'0"W X 3'0"D	2200	CY		—				—		19 500	
	BUILDING PREFAB	2400	SF		—				—		29 000	
	CONCRETE	150	CY		—				—		34 000	
	ELECTRICAL	4%			—				—		50 000	
	TEST & SUPV				588							
					6468	35	226 380		338 500		150 000	714 880

FACILITY WASTE ISOLATION PILOT PLANT

TYPE OF ESTIMATE COST STUDY JOB NO. 8251.10 SHEET NO. 2 OF 4 PRINCIPAL SUB ACCT. NO. ALT I

EE-32 OCT 70 REV

DETAIL ESTIMATE SHEET

HOLMES & NARVER, INC.
ENGINEERS - CONSTRUCTORS

ACTION	BY	DATE	CHECKED	DATE
PRICED	AKO	3-15-79		
EXTENSIONS				

ACCT. NO	DESCRIPTION	QUANTITY	UNIT	LABOR				MATERIAL		SUBCONTRACTS		TOTAL COST
				LABOR UNIT	TOTAL HRS	RATE HR.	AMOUNT	COST UNIT	AMOUNT	COST UNIT	AMOUNT	
	ALTERNATE II											
	TRU BLDG.											
	225 TON HEAT PUMPS	2	EA		160				87000			
	" COOLING TWR	2									8600	
	25 HP PUMPS	4			64				4600			
	HEAT EXCHANGER	1			16				1000			
	RH BLDG											
	150 TON HEAT PUMPS	2	EA		120				76800			
	" COOLING TOWERS	2									6600	
	15 HP PUMPS	4			60				3800			
	HEAT EXCHANGER	1			16				900			
	ADM. BLDG											
	75 TON RECIP HEAT PUMP	2	EA		100				40000			
	" COOLING TOWER	2									4600	
	10 HP PUMP	4			48				3000			
	HEAT EXCHANGER	1			16				800			
	TEST & SUPV	4/3			100							
	CONCRETE	18	CY		~~0~~						4000	
					700	35	24500		217900		23800	266200

FACILITY WASTE ISOLATION PILOT PLANT

TYPE OF ESTIMATE COST STUDY JOB NO. 8251.10 SHEET NO. 3 OF 4 PRINCIPAL SUB ACCT. NO. ACT II

22

DETAIL ESTIMATE SHEET

HOLMES & NARVER, INC. ENGINEERS — CONSTRUCTORS

FACTOR	BY	DATE	CHECKED	DATE
PRICED	WV	3-15-76		
EXTENSIONS				

ACCT. NO.	DESCRIPTION	QUANTITY	UNIT	LABOR: LABOR UNIT	LABOR: TOTAL HRS	LABOR: RATE $/HR	LABOR: AMOUNT	MATERIAL: COST/UNIT	MATERIAL: AMOUNT	SUBCONTRACTS: COST/UNIT	SUBCONTRACTS: AMOUNT	TOTAL COST
	ALTERNATE III											
	300 TON COOLING TWR	3	EA		—						17 400	
	50 HP PUMPS	3	"		72				4 600			
	10" ϕ PIPE INSULATED	3720	LF		2604				109 160			
	TRENCH & BACKFILL	1800	CY								16 600	
	TRU BLOC											
	225 TON HEAT PUMPS	2	EA		160				87 000			
	25 HP PUMPS	2			32				2 300			
	HEAT EXCHANGER	1	"		16				1 000			
	RH BLOC											
	150 TON HEAT PUMP	2	EA		120				76 800			
	15 HP PUMP	2			30				1 900			
	HEAT EXCHANGER	1	"		16				900			
	ADM. BLOC											
	75 TON HEAT PUMP	2	EA		100				40 000			
	10 HP PUMP	2			24				1 500			
	HEAT EXCHANGER	1	"		16				700			
	CONCRETE	11	CY		—						2 500	
	TEST & SUPV	48			300							
					3324	35	116 340		320 860		36 500	473 700

FACILITY WASTE ISOLATION PILOT PLANT

TYPE OF ESTIMATE COST STUDY JOB NO. B251.10 SHEET NO. 4 OF 4 PRINCIPAL SUB ACCT. NO. ALT III

FORM 307-10-REV

APPENDIX B

LIFCY 1 COMPUTER RUNS

$$$$ LIFE-CYCLE COST COMPARISONS $$$$

◆◆INPUT DATA◆◆

BLDG: RH #1 LOCATION: WIPP
PROJ. DIR. NO.: 4-01-77 DESIGNER: M. KLATSKIN

COST OF ELECTRICAL ENERGY USED, PER MILLION BTU = $7.9990
COST OF STEAM, GAS OR OTHER ENERGY USED, PER MBTU = $.0000
YEARLY ESCALATION RATE FOR ELECTRICITY IS 5.7 %
YEARLY ESCALATION RATE FOR STEAM, GAS OR OIL IS .0 %
YEARLY DISCOUNT RATE IS 8.0 %
NUMBER OF ALTERNATIVES BEING CONSIDERED ARE 2 ALTERNATES

◆◆◆RESULTS OF ECONOMIC STUDY◆◆◆

ALTERNATE NO. 1 DATA (CENT HEAT PUMP)
INSTALLATION FIRST COST..... $375,000.00
ANNUAL O & M COST (LESS ENERGY).... $15,000.00
ELECTRICAL ENERGY USED..... 4903 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 39219.1 DOLLARS
TOTAL ANNUALIZED COST IS 120399. DOLLARS
TOTAL PRESENT WORTH IS 1.28523E+6 DOLLARS

ALTERNATE NO. 2 DATA (CENT HEAT PUMP W/HEAT RECOVERY)
INSTALLATION FIRST COST..... $425,000.00
ANNUAL O & M COST (LESS ENERGY).... $17,000.00
ELECTRICAL ENERGY USED..... 3762 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 30092.2 DOLLARS
TOTAL ANNUALIZED COST IS 110730. DOLLARS
TOTAL PRESENT WORTH IS 1.18202E+6 DOLLARS

◆◆◆DISCOUNTED PAYBACK PERIODS◆◆◆

TO GO FROM ALTERNATE 1◆ TO ALTERNATE 2 PAYBACK IS 7.2 YEARS
FINAL (YEAR 8) YEARS ENERGY SAVINGS/COST IS 1.422E+1 DOLLARS
WITH 1,141 MILLIONS OF BTU SAVED PER YEAR.
SAVINGS/INVESTMENT RATIO IS 3.064
ENERGY SAVINGS IS 570,500 BTU PER ANNUAL DISCOUNTED INVESTMENT DOLLAR.

◆ - LOWEST INCREMENTAL INSTALLATION FIRST COST ALTERNATE

77/04/01. 10.41.32.
PROGRAM LIFCY1

$$$$ LIFE-CYCLE COST COMPARISONS $$$$

◆◆INPUT DATA◆◆

BLDG: RH #2 LOCATION: WIPP
PROJ. DIR. NO.: 4-01-77 DESIGNER: M. KLATSKIN

COST OF ELECTRICAL ENERGY USED, PER MILLION BTU = $7.9990
COST OF STEAM, GAS OR OTHER ENERGY USED, PER MBTU = $.0000
YEARLY ESCALATION RATE FOR ELECTRICITY IS 5.7 %
YEARLY ESCALATION RATE FOR STEAM, GAS OR OIL IS .0 %
YEARLY DISCOUNT RATE IS 8.0 %
NUMBER OF ALTERNATIVES BEING CONSIDERED ARE 2 ALTERNATES

◆◆◆RESULTS OF ECONOMIC STUDY◆◆◆

ALTERNATE NO. 1 DATA (CENT HEAT PUMP W/HEAT RECOVERY)
INSTALLATION FIRST COST..... $425,000.00
ANNUAL O & M COST (LESS ENERGY).... $17,000.00
ELECTRICAL ENERGY USED..... 3762 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 30092.2 DOLLARS
TOTAL ANNUALIZED COST IS 110730. DOLLARS
TOTAL PRESENT WORTH IS 1.18202E+6 DOLLARS

ALTERNATE NO. 2 DATA (CENT HEAT PUMP W/HEAT RECOV & EVAP COOL)
INSTALLATION FIRST COST..... $449,000.00
ANNUAL O & M COST (LESS ENERGY).... $18,000.00
ELECTRICAL ENERGY USED..... 2758 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 22061.2 DOLLARS
TOTAL ANNUALIZED COST IS 99589.1 DOLLARS
TOTAL PRESENT WORTH IS 1.06309E+6 DOLLARS

◆◆◆DISCOUNTED PAYBACK PERIODS◆◆◆

TO GO FROM ALTERNATE 1◆ TO ALTERNATE 2 PAYBACK IS 3.5 YEARS
FINAL (YEAR 4) YEARS ENERGY SAVINGS/COST IS 1.002E+1 DOLLARS
WITH 1,004 MILLIONS OF BTU SAVED PER YEAR.
SAVINGS/INVESTMENT RATIO IS 5.955
ENERGY SAVINGS IS 1,045,833 BTU PER ANNUAL DISCOUNTED INVESTMENT DOLLAR.

◆ - LOWEST INCREMENTAL INSTALLATION FIRST COST ALTERNATE

77/04/06. 09.33.27.
PROGRAM LIFCY1

$$$$ LIFE-CYCLE COST COMPARISONS $$$$

◆◆INPUT DATA◆◆

BLDG. RH-3 LOCATION: WIPP
PROJ. DIR. NO.: 4-6-77 DESIGNER: H-N

COST OF ELECTRICAL ENERGY USED, PER MILLION BTU = $7.9990
COST OF STEAM, GAS OR OTHER ENERGY USED, PER MBTU = $.0000
YEARLY ESCALATION RATE FOR ELECTRICITY IS 5.7 %
YEARLY ESCALATION RATE FOR STEAM, GAS OR OIL IS .0 %
YEARLY DISCOUNT RATE IS 8.0 %
NUMBER OF ALTERNATIVES BEING CONSIDERED ARE 2 ALTERNATES

◆◆◆RESULTS OF ECONOMIC STUDY◆◆◆

ALTERNATE NO. 1 DATA (BASE SYSTEM)
INSTALLATION FIRST COST..... $449,000.00
ANNUAL O & M COST (LESS ENERGY).... $18,000.00
ELECTRICAL ENERGY USED..... 2758 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 22061.2 DOLLARS
TOTAL ANNUALIZED COST IS 99589.1 DOLLARS
TOTAL PRESENT WORTH IS 1.06309E+6 DOLLARS

ALTERNATE NO. 2 DATA (BASE WITH SOLAR ASSIST)
INSTALLATION FIRST COST..... $471,400.00
ANNUAL O & M COST (LESS ENERGY).... $22,000.00
ELECTRICAL ENERGY USED..... 1422 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 11374.6 DOLLARS
TOTAL ANNUALIZED COST IS 95908. DOLLARS
TOTAL PRESENT WORTH IS 1.02380E+6 DOLLARS

◆◆◆DISCOUNTED PAYBACK PERIODS◆◆◆

TO GO FROM ALTERNATE 1◆ TO ALTERNATE 2 PAYBACK IS 18.3 YEARS
FINAL (YEAR 19) YEARS ENERGY SAVINGS/COST IS 3.064E+1 DOLLARS
WITH 1,336 MILLIONS OF BTU SAVED PER YEAR.
SAVINGS/INVESTMENT RATIO IS 1.321
ENERGY SAVINGS IS 272,875 BTU PER ANNUAL DISCOUNTED INVESTMENT DOLLAR.

◆ - LOWEST INCREMENTAL INSTALLATION FIRST COST ALTERNATE

```
 77/04/01.  10.37.05.
PROGRAM   LIFCY1

04030 DATA "RH       #1"
04040 DATA "WIPP"
04050 DATA "4-01-77"
04060 DATA "M. KLATSKIN"
04070 DATA 7.999
04080 DATA 0
04090 DATA 5,7
04100 DATA 0
04110 DATA 8
04120 DATA 2
04130 DATA "CENT HEAT PUMP"
04140 DATA 375000
04150 DATA 15000
04160 DATA 4903
04170 DATA 0
04180 DATA 25
04190 DATA "CENT HEAT PUMP W/HEAT RECOVERY"
04200 DATA 425000
04210 DATA 17000
04220 DATA 3762
04230 DATA 0
04240 DATA 25
06350 END
READY.
```

```
 77/04/01. 10.40.55.
PROGRAM   LIFCY1

04030 DATA "RH      #2"
04040 DATA "WIPP"
04050 DATA "4-01-77"
04060 DATA "M. KLATSKIN"
04070 DATA 7.999
04080 DATA 0
04090 DATA 5.7
04100 DATA 0
04110 DATA 8
04120 DATA 2
04130 DATA "CENT HEAT PUMP W/HEAT RECOVERY"
04140 DATA 425000
04150 DATA 17000
04160 DATA 3762
04170 DATA 0
04180 DATA 25
04190 DATA "CENT HEAT PUMP W/HEAT RECOV & EVAP COOL"
04200 DATA 449000
04210 DATA 18000
04220 DATA 2758
04230 DATA 0
04240 DATA 25
06350 END
READY.
```

```
 77/04/06.  09.31.52.
PROGRAM    RH3

04030 DATA "RH-3"
04040 DATA "WIPP"
04050 DATA "4-6-77"
04060 DATA "H-N"
04070 DATA 7.999
04080 DATA 0
04090 DATA 5.7
04100 DATA 0
04110 DATA 8
04120 DATA 2
04130 DATA "BASE SYSTEM"
04140 DATA 449000
04150 DATA 18000
04160 DATA 2758
04170 DATA 0
04180 DATA 25
04190 DATA "BASE WITH SOLAR ASSIST"
04200 DATA 571400
04210 DATA 22000
04220 DATA 1422
04230 DATA 0
04240 DATA 25
READY.
```

77/04/08. 08.27.10.
PROGRAM LIFCY1

$$$$ LIFE-CYCLE COST COMPARISONS $$$$

◆◆INPUT DATA◆◆

BLDG# TRU-1 LOCATION: WIPP
PROJ. DIR. NO.: 4-7-77 DESIGNER: H-N

COST OF ELECTRICAL ENERGY USED, PER MILLION BTU = $7.9800
COST OF STEAM, GAS OR OTHER ENERGY USED, PER MBTU = $.0000
YEARLY ESCALATION RATE FOR ELECTRICITY IS 5.7 %
YEARLY ESCALATION RATE FOR STEAM, GAS OR OIL IS .0 %
YEARLY DISCOUNT RATE IS 8.0 %
NUMBER OF ALTERNATIVES BEING CONSIDERED ARE 2 ALTERNATES

◆◆◆RESULTS OF ECONOMIC STUDY◆◆◆

ALTERNATE NO. 1 DATA (HEAT PUMP)
INSTALLATION FIRST COST..... $800,000.00
ANNUAL O & M COST (LESS ENERGY).... $32,000.00
ELECTRICAL ENERGY USED..... 6725 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 53665.5 DOLLARS
TOTAL ANNUALIZED COST IS 203096. DOLLARS
TOTAL PRESENT WORTH IS 2.16800E+6 DOLLARS

ALTERNATE NO. 2 DATA (HEAT PUMP W/RECOVERY)
INSTALLATION FIRST COST..... $875,000.00
ANNUAL O & M COST (LESS ENERGY).... $35,000.00
ELECTRICAL ENERGY USED..... 5160 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 41176.8 DOLLARS
TOTAL ANNUALIZED COST IS 190746. DOLLARS
TOTAL PRESENT WORTH IS 2.03617E+6 DOLLARS

◆◆◆DISCOUNTED PAYBACK PERIODS◆◆◆

TO GO FROM ALTERNATE 1◆ TO ALTERNATE 2 PAYBACK IS 8.2 YEARS
FINAL (YEAR 9) YEARS ENERGY SAVINGS/COST IS 2.057E+1 DOLLARS
WITH 1,565 MILLIONS OF BTU SAVED PER YEAR.
SAVINGS/INVESTMENT RATIO IS 2.758
ENERGY SAVINGS IS 521,666 BTU PER ANNUAL DISCOUNTED INVESTMENT DOLLAR.

◆ - LOWEST INCREMENTAL INSTALLATION FIRST COST ALTERNATE

77/04/08. 08.42.40.
PROGRAM LIFCY1

$$$$ LIFE-CYCLE COST COMPARISONS $$$$

◆◆INPUT DATA◆◆

BLDG: TRU-2 LOCATION: WIPP
PROJ. DIR. NO.: 4-7-77 DESIGNER: H-N

COST OF ELECTRICAL ENERGY USED, PER MILLION BTU = $7.9800
COST OF STEAM, GAS OR OTHER ENERGY USED, PER MBTU = $.0000
YEARLY ESCALATION RATE FOR ELECTRICITY IS 5.7 %
YEARLY ESCALATION RATE FOR STEAM, GAS OR OIL IS .0 %
YEARLY DISCOUNT RATE IS 8.0 %
NUMBER OF ALTERNATIVES BEING CONSIDERED ARE 2 ALTERNATES

◆◆◆RESULTS OF ECONOMIC STUDY◆◆◆

ALTERNATE NO. 1 DATA (HEAT PUMP W/RECOVERY)
INSTALLATION FIRST COST..... $875,000.00
ANNUAL O & M COST (LESS ENERGY).... $35,000.00
ELECTRICAL ENERGY USED..... 5160 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 41176.8 DOLLARS
TOTAL ANNUALIZED COST IS 190746. DOLLARS
TOTAL PRESENT WORTH IS 2.03617E+6 DOLLARS

ALTERNATE NO. 2 DATA (HEAT PUMP W/RECOVERY & EVAP COOLING)
INSTALLATION FIRST COST..... $923,000.00
ANNUAL O & M COST (LESS ENERGY).... $36,900.00
ELECTRICAL ENERGY USED..... 3148 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 25121. DOLLARS
TOTAL ANNUALIZED COST IS 168375. DOLLARS
TOTAL PRESENT WORTH IS 1.79737E+6 DOLLARS

◆◆◆DISCOUNTED PAYBACK PERIODS◆◆◆

TO GO FROM ALTERNATE 1◆ TO ALTERNATE 2 PAYBACK IS 3.5 YEARS
FINAL (YEAR 4) YEARS ENERGY SAVINGS/COST IS 2.004E+1 DOLLARS
WITH 2,012 MILLIONS OF BTU SAVED PER YEAR.
SAVINGS/INVESTMENT RATIO IS 5.975
ENERGY SAVINGS IS 1,047,916 BTU PER ANNUAL DISCOUNTED INVESTMENT DOLLAR.

◆ - LOWEST INCREMENTAL INSTALLATION FIRST COST ALTERNATE

77/04/08. 08.46.21.
PROGRAM LIFCY1

$$$$ LIFE-CYCLE COST COMPARISONS $$$$

◆◆INPUT DATA◆◆

BLDG: TRU-3 LOCATION: WIPP
PROJ. DIR. NO.: 4-7-77 DESIGNER: H-N

COST OF ELECTRICAL ENERGY USED, PER MILLION BTU = $7.9800
COST OF STEAM, GAS OR OTHER ENERGY USED, PER MBTU = $.0000
YEARLY ESCALATION RATE FOR ELECTRICITY IS 5.7 %
YEARLY ESCALATION RATE FOR STEAM, GAS OR OIL IS .0 %
YEARLY DISCOUNT RATE IS 8.0 %
NUMBER OF ALTERNATIVES BEING CONSIDERED ARE 2 ALTERNATES

◆◆◆RESULTS OF ECONOMIC STUDY◆◆◆

ALTERNATE NO. 1 DATA (HEAT PUMP W/RECOVERY & EVAP COOLING)
INSTALLATION FIRST COST..... $923,000.00
ANNUAL O & M COST (LESS ENERGY).... $36,900.00
ELECTRICAL ENERGY USED..... 3148 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 25121. DOLLARS
TOTAL ANNUALIZED COST IS 168375. DOLLARS
TOTAL PRESENT WORTH IS 1.79737E+6 DOLLARS

ALTERNATE NO. 2 DATA (HEAT PUMP W/RECOVERY & EVAP COOLING & SOLAR ASSIST)
INSTALLATION FIRST COST..... $1,045,400.00
ANNUAL O & M COST (LESS ENERGY).... $41,000.00
ELECTRICAL ENERGY USED..... 1812 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 14459.8 DOLLARS
TOTAL ANNALIZED COST IS 164839. DOLLARS
TOTAL PRESENT WORTH IS 1.75962E+6 DOLLARS

◆◆◆DISCOUNTED PAYBACK PERIODS◆◆◆

TO GO FROM ALTERNATE 1◆ TO ALTERNATE 2 PAYBACK IS 18.5 YEARS
FINAL (YEAR 19) YEARS ENERGY SAVINGS/COST IS 3.057E+1 DOLLARS
WITH 1,336 MILLIONS OF BTU SAVED PER YEAR.
SAVINGS/INVESTMENT RATIO IS 1.308
ENERGY SAVINGS IS 272,875 BTU PER ANNUAL DISCOUNTED INVESTMENT DOLLAR.

◆ - LOWEST INCREMENTAL INSTALLATION FIRST COST ALTERNATE

```
 77/04/08.  08.25.52.
PROGRAM   LIFCY1

04030 DATA "TRU-1"
04040 DATA "WIPP"
04050 DATA "4-7-77"
04060 DATA "H-N"
04070 DATA 7.98
04080 DATA 0
04090 DATA 5.7
04100 DATA 0
04110 DATA 8
04120 DATA 2
04130 DATA "HEAT PUMP"
04140 DATA $00000
04150 DATA 32000
04160 DATA 6725
04170 DATA 0
04180 DATA 25
04190 DATA "HEAT PUMP W/RECOVERY"
04200 DATA 875000
04210 DATA 35000
04220 DATA 5160
04230 DATA 0
04240 DATA 25
06350 END
READY.
```

```
 77/04/08.  08.34.20.
PROGRAM   LIFCY1

04030 DATA "TRU-2"
04040 DATA "WIPP"
04050 DATA "4-7-77"
04060 DATA "H-N"
04070 DATA 7.98
04080 DATA 0
04090 DATA 5.7
04100 DATA 0
04110 DATA 8
04120 DATA 2
04130 DATA "HEAT PUMP W/RECOVERY"
04140 DATA 875000
04150 DATA 35000
04160 DATA 5160
04170 DATA 0
04180 DATA 25
04190 DATA "HEAT PUMP W/RECOVERY & EVAP COOLING"
04200 DATA 923000
04210 DATA 36900
04220 DATA 3148
04230 DATA 0
04240 DATA 25
READY.
```

```
 77/04/08.  08.45.40.
PROGRAM   LIFCY1

04030 DATA "TRU-3"
04040 DATA "WIPP"
04050 DATA "4-7-77"
04060 DATA "H-N"
04070 DATA 7.98
04080 DATA 0
04090 DATA 5.7
04100 DATA 0
04110 DATA 8
04120 DATA 2
04130 DATA "HEAT PUMP W/RECOVERY & EVAP COOLING"
04140 DATA 923000
04150 DATA 36900
04160 DATA 3148
04170 DATA 0
04180 DATA 25
04190 DATA "HEAT PUMP W/RECOVERY & EVAP COOLING & SOLAR ASSIST"
04200 DATA 1045400
04210 DATA 41000
04220 DATA 1812
04230 DATA 0
04240 DATA 25
06350 END
READY.
```

3-28-77
Eg

$$$$ LIFE-CYCLE COST COMPARISONS $$$$

◆◆INPUT DATA◆◆

BLDG: ADMINISTRATION BLDG. LOCATION: WIPP
PROJ. DIR. NO.: CONCEPTUAL DESIGN DESIGNER:
KLATSKIN / BROWN

COST OF ELECTRICAL ENERGY USED, PER MILLION BTU = $9.0243
COST OF STEAM, GAS OR OTHER ENERGY USED, PER MBTU = $.0000
YEARLY ESCALATION RATE FOR ELECTRICITY IS 5.7 %
YEARLY ESCALATION RATE FOR STEAM, GAS OR OIL IS .0 %
YEARLY DISCOUNT RATE IS 8.0 %
NUMBER OF ALTERNATIVES BEING CONSIDERED ARE 2 ALTERNATES

◆◆◆RESULTS OF ECONOMIC STUDY◆◆◆

ALTERNATE NO. 1 DATA (RECIP HEAT PUMP)
INSTALLATION FIRST COST..... $105,000.00
ANNUAL O & M COST (LESS ENERGY).... $4,200.00
ELECTRICAL ENERGY USED..... 2483.97 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 22416.1 DOLLARS
TOTAL ANNUALIZED COST IS 54199.3 DOLLARS
TOTAL PRESENT WORTH IS 578566. DOLLARS

ALTERNATE NO. 2 DATA (RECIP H.P. W/EVAP)
INSTALLATION FIRST COST..... $120,000.00
ANNUAL O & M COST (LESS ENERGY).... $4,800.00
ELECTRICAL ENERGY USED..... 1901.2 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 17157. DOLLARS
TOTAL ANNUALIZED COST IS 46781.8 DOLLARS
TOTAL PRESENT WORTH IS 499385. DOLLARS

◆◆◆DISCOUNTED PAYBACK PERIODS◆◆◆

TO GO FROM ALTERNATE 1◆ TO ALTERNATE 2 PAYBACK IS 3.3 YEARS
FINAL (YEAR 4) YEARS ENERGY SAVINGS/COST IS 6.565E+0 DOLLARS
WITH 582 MILLIONS OF BTU SAVED PER YEAR.
SAVINGS/INVESTMENT RATIO IS 6.279
ENERGY SAVINGS IS 971,283 BTU PER ANNUAL DISCOUNTED INVESTMENT DOLLAR.

◆ - LOWEST INCREMENTAL INSTALLATION FIRST COST ALTERNATE

77/04/06. 14.09.47.
PROGRAM LIFCY1

$$$$ LIFE-CYCLE COST COMPARISONS $$$$

◆◆INPUT DATA◆◆

BLDG: ADMINISTRATION LOCATION: WIPP
PROJ. DIR. NO.: 4-6-77 DESIGNER: H-N

COST OF ELECTRICAL ENERGY USED, PER MILLION BTU = $9.0200
COST OF STEAM, GAS OR OTHER ENERGY USED, PER MBTU = $.0000
YEARLY ESCALATION RATE FOR ELECTRICITY IS 5.7 %
YEARLY ESCALATION RATE FOR STEAM, GAS OR OIL IS .0 %
YEARLY DISCOUNT RATE IS 8.0 %
NUMBER OF ALTERNATIVES BEING CONSIDERED ARE 2 ALTERNATES

◆◆◆RESULTS OF ECONOMIC STUDY◆◆◆

ALTERNATE NO. 1 DATA (HEAT PUMP)
INSTALLATION FIRST COST..... $.00
ANNUAL O & M COST (LESS ENERGY).... $.00
ELECTRICAL ENERGY USED..... 1336 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 12050.7 DOLLARS
TOTAL ANNUALIZED COST IS 21591.4 DOLLARS
TOTAL PRESENT WORTH IS 230483. DOLLARS

ALTERNATE NO. 2 DATA (HEAT PUMP W/SOLAR ASSIST)
INSTALLATION FIRST COST..... $122,400.00
ANNUAL O & M COST (LESS ENERGY).... $4,000.00
ELECTRICAL ENERGY USED..... 0 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 0 DOLLARS
TOTAL ANNUALIZED COST IS 15466.3 DOLLARS
TOTAL PRESENT WORTH IS 165099. DOLLARS

◆◆◆DISCOUNTED PAYBACK PERIODS◆◆◆

TO GO FROM ALTERNATE 1◆ TO ALTERNATE 2 PAYBACK IS 15.5 YEARS
FINAL (YEAR 16) YEARS ENERGY SAVINGS/COST IS 2.926E+1 DOLLARS
WITH 1,336 MILLIONS OF BTU SAVED PER YEAR.
SAVINGS/INVESTMENT RATIO IS 1.534
ENERGY SAVINGS IS 272,875 BTU PER ANNUAL DISCOUNTED INVESTMENT DOLLAR.

◆ - LOWEST INCREMENTAL INSTALLATION FIRST COST ALTERNATE

```
 77/04/06.  14.09.14.
PROGRAM   LIFCY1

04030 DATA "ADMINISTRATION "
04040 DATA "WIPP"
04050 DATA "4-6-77"
04060 DATA "H-N"
04070 DATA 9.02
04080 DATA 0
04090 DATA 5.7
04100 DATA 0
04110 DATA 8
04120 DATA 2
04130 DATA "HEAT PUMP"
04140 DATA 0
04150 DATA 0
04160 DATA 1336
04170 DATA 0
04180 DATA 25
04190 DATA "HEAT PUMP W/SOLAR ASSIST"
04200 DATA 122400
04210 DATA 4000
04220 DATA 0
04230 DATA 0
04240 DATA 25
06350 END
READY.
```

77/04/06. 14.16.33.
PROGRAM LIFCY1

$$$$ LIFE-CYCLE COST COMPARISONS $$$$

◆◆INPUT DATA◆◆

BLDG: LAUNDRY HOT WATER — LOCATION: WIPP
PROJ. DIR. NO.: 4-6-77 — DESIGNER: H-N

COST OF ELECTRICAL ENERGY USED, PER MILLION BTU = $17.3450
COST OF STEAM, GAS OR OTHER ENERGY USED, PER MBTU = $.0000
YEARLY ESCALATION RATE FOR ELECTRICITY IS 5.7 %
YEARLY ESCALATION RATE FOR STEAM, GAS OR OIL IS .0 %
YEARLY DISCOUNT RATE IS 8.0 %
NUMBER OF ALTERNATIVES BEING CONSIDERED ARE 2 ALTERNATES

◆◆◆RESULTS OF ECONOMIC STUDY◆◆◆

ALTERNATE NO. 1 DATA (ELECTRIC HEATER)
INSTALLATION FIRST COST..... $.00
ANNUAL O & M COST (LESS ENERGY).... $.00
ELECTRICAL ENERGY USED..... 128 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 2220.16 DOLLARS
TOTAL ANNUALIZED COST IS 3977.88 DOLLARS
TOTAL PRESENT WORTH IS 42462.9 DOLLARS

ALTERNATE NO. 2 DATA (SOLAR HTR.-BOOSTER)
INSTALLATION FIRST COST..... $18,360.00
ANNUAL O & M COST (LESS ENERGY).... $700.00
ELECTRICAL ENERGY USED..... 0 MILLION BTU
STEAM, GAS AND/OR OIL USED..... 0 MILLION BTU
ECONOMIC LIFE..... 25 YEARS

RESULTS
TOTAL FIRST YEAR ENERGY COST IS 0 DOLLARS
TOTAL ANNUALIZED COST IS 2419.94 DOLLARS
TOTAL PRESENT WORTH IS 25832.3 DOLLARS

◆◆◆DISCOUNTED PAYBACK PERIODS◆◆◆

TO GO FROM ALTERNATE 1◆ TO ALTERNATE 2 PAYBACK IS 12.3 YEARS
FINAL (YEAR 13) YEARS ENERGY SAVINGS/COST IS 4.564E+0 DOLLARS
WITH 128 MILLIONS OF BTU SAVED PER YEAR.
SAVINGS/INVESTMENT RATIO IS 1.906
ENERGY SAVINGS IS 174,291 BTU PER ANNUAL DISCOUNTED INVESTMENT DOLLAR.

◆ - LOWEST INCREMENTAL INSTALLATION FIRST COST ALTERNATE

```
 77/04/06. 14.16.00.
PROGRAM   LIFCY1

04030 DATA "LAUNDRY HOT WATER"
04040 DATA "WIPP"
04050 DATA "4-6-77"
04060 DATA "H-N"
04070 DATA 17.345
04080 DATA 0
04090 DATA 5.7
04100 DATA 0
04110 DATA 8
04120 DATA 2
04130 DATA "ELECTRIC HEATER"
04140 DATA 0
04150 DATA 0
04160 DATA 128
04170 DATA 0
04180 DATA 25
04190 DATA "SOLAR HTR.-BOOSTER"
04200 DATA 18360
04210 DATA 700
04220 DATA 0
04230 DATA 0
04240 DATA 25
06350 END
READY.
```