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PRELIMINARY EVALUATION OF GEOTHERMAL SPACE HEATING AT SIERRA ARMY DEPOT

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INTRODUCTION

A geothermal heating system for Sierra Army Depot was scoped which can significantly reduce the present use of conventional fuels. This geothermal heating system will reduce heating costs, conserve conventional fuels and reduce emissions to the atmosphere. The geology of the Base indicates a plentiful supply of hot geothermal fluid.

SUMMARY

A geothermal district heating system for Sierra Army Depot was economically feasible. Engineering-economic analysis assumed a 245°F geothermal source, requiring a peak flow of 582 gpm that is located 3 miles from the main building heat loads. Injection wells are located adjacent to the main building complex. With proper reinjection of the geothermal fluid, it is estimated that the heating life cycle can be significantly increased beyond the 20 year period used for this analysis.

Total project cost including all retrofit, is $6,891,420 and yearly operating and maintenance expense totals $156,097. Simple and discounted payback periods for the geothermal heating system is shown as follows:

6.93 years simple payback
9.32 years discounted (7%) payback

Presently 92.3 x 10^9 Btu per year is used annually at Sierra Army Depot to space heat approximately 2 x 10^6 square feet of buildings and supply hot water for domestic use.

Tables 1 and II show a breakdown for the geothermal capital and yearly expenses.

TABLE 1

SIERRA ARMY DEPOT GEOTHERMAL HEATING SYSTEM CAPITAL COST

(245°F Geothermal Fluid)

Resource Exploration and Feasibility Studies	$ 533,000
Geothermal Wells:	
Production Well	1,625,000
Injection Well	500,000
Subtotal Geothermal Wells	$2,125,000
Geothermal Supply System:	
Wellhead Equipment & Controls	74,000
Injection Pumps	12,000
Surge Tank	50,000
Filters	43,650
Valves	10,000
Heat Exchangers	14,340
Transmission Piping & Pumps	647,760
Equipment Installation	39,000
Mechanical Building	75,000
Subtotal Geothermal Supply System	$ 965,750
Distribution System:	
Piping, Pumps & Controls	907,500
User Building Retrofits	820,000
Equipment Installation	272,250
Subtotal Distribution System	$1,999,750
Total Project Direct Costs	$5,623,500
Contractor Markup and Construction Management	444,825
Design	148,275
Contingency	674,820
Total Project Capital Cost	$6,891,420

TABLE II

SIERRA ARMY DEPOT GEOTHERMAL OPERATIONS AND MAINTENANCE - PRELIMINARY

(245°F Geothermal Fluid)

Yearly Expense

Operating Expenses:	
Electricity ($ .11 per kWh)	
Primary System Pumps	$ 17,500
Injection Well Pump	23,437
Recirculation System Pumps	45,235
Total Operating Expenses, Yearly	$ 86,172
Maintenance Expenses:	
Pumps (Injection, Recirculation)	2,100
Geo-fluid Filters	1,300
Distribution System Piping & Controls	27,225
Collection/Injection Field Piping & Controls	18,500
Heat Exchangers	800
Production & Injection Well	20,000
Total Maintenance, Yearly	$ 69,925
Total Yearly Operations and Maintenance Cost	$ 156,097
Yearly Expenses, Presently:	
Heating Oil, Coal and Propane	807,444
Equipment Maintenance (estimated)	201,861
	$1,009,305

Geothermal Heating System

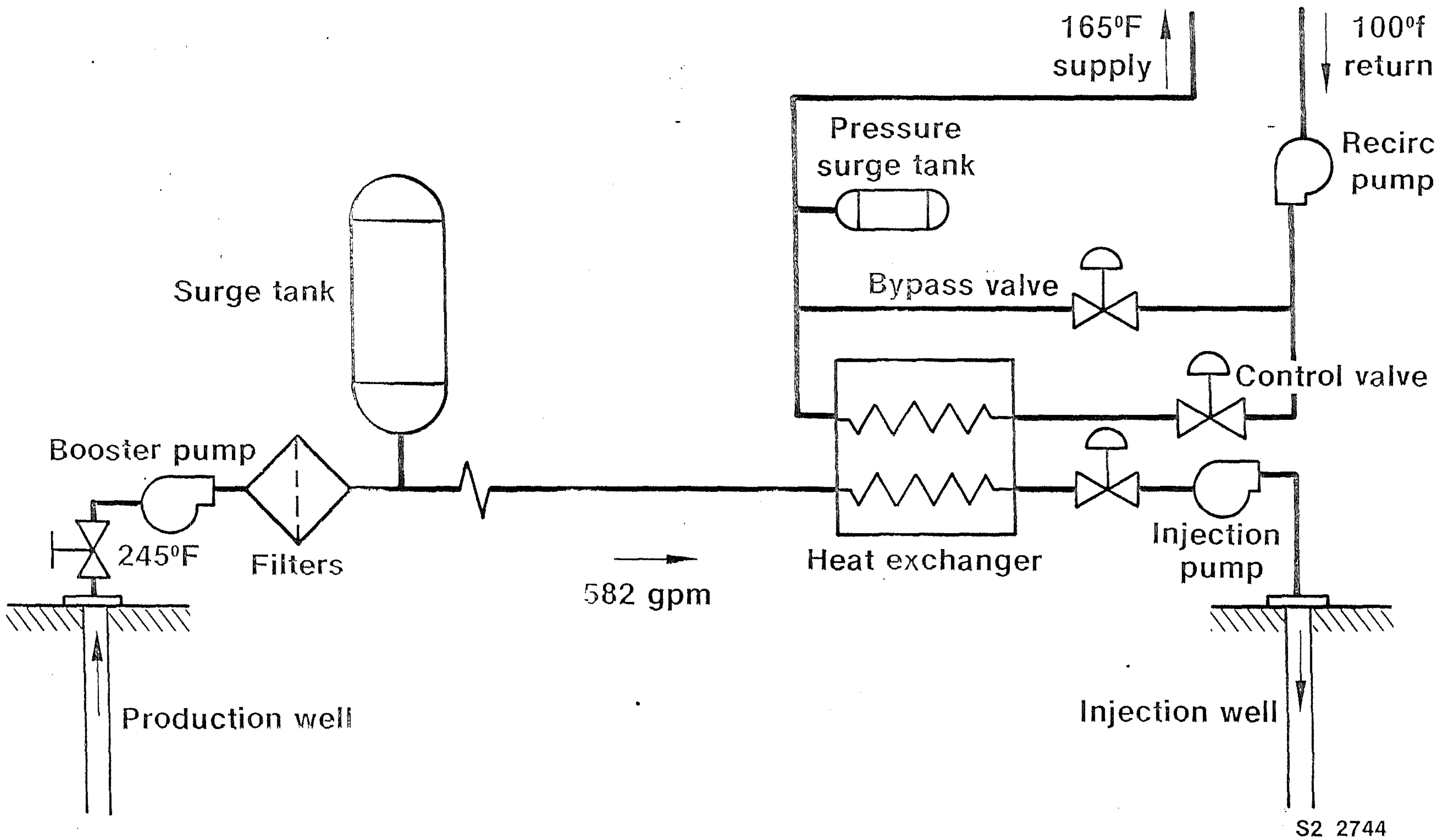

FIGURE 1

SYSTEM HEATING REQUIREMENTS

Of the 92.3 x 10^9 Btu per year presently used at Sierra Army Depot for space and hot water heating, a conversion efficiency .8 was assumed for conversion of the fossil fuel to thermal energy. The proposed geothermal system has a conversion efficiency of near 1.0 and supplies 100% of the annual heating load requirement. Except for a small electrical load for pumping, this design is solely powered by geothermal energy and thereby conserves fossil fuels. Figure 1 is a schematic diagram of the proposed geothermal heating system.

A single production well was projected to produce the necessary total of 582 gpm of 245°F geothermal water to satisfy system peak heating requirements. As the thermal load decreases, the peak supply temperature of 165°F is decreased. The heating system is controlled by maintaining the return fluid temperature at approximately 100°F.

Plant equipment was costed on the basis of one whole production well and one whole injection well. It is estimated that 75% of well capacity will be utilized at peak heating load, allowing significant capability for expansion.

DESCRIPTION OF SYSTEM

A single geothermal well supplies 245°F to the primary side of the heating system heat exchanger through an 8-inch insulated steel pipe. Booster pumps are used to transport hot geothermal fluid. The geothermal water is reinjected after being reduced in temperature to approximately 110°F.

The geothermal water passes through filters before entering plate type heat exchangers thereby minimizing fouling problems on the geothermal side of the system.

Clean water is circulated through the secondary loop of the heating system. The heat energy delivered to thermal load is controlled by controlling the water return temperature to approximately 100°F. A bypass is provided for heating water to circumvent the central system heat exchanger.

Retrofit costs are included for the installation of natural and forced air convective units as well as domestic hot water tanks which operate on the distribution system. Piping materials consider the use of insulated carbon steel pipe for the geothermal supply system and insulated non-ferrous piping in the distribution system. Final piping material selection for the geothermal supply system would not be made until testing of the production well established temperature, flow rate and water chemistry.

ECONOMIC ANALYSIS

A 20-year economic analysis was performed comparing the projected geothermal system capital costs and operations and maintenance costs versus continued use of fossil fuels. This analysis used a 7% discount rate for future projected savings and escalated the cost of fossil fuels presently used at 6% per year. Electricity costs to operate the geothermal systems were escalated at 2% per year. All costs are in present dollars (no inflation).

The following tabulation, the "savings" represent the cost of not operating the present system; the "expenses" represent the cost of operating the geothermal system, electricity and maintenance; and the net revenue is the difference between savings and expenses. NPV is the present value of the Net Revenue discounted at 7%. Simple and discounted (at 7%) payback periods have also been calculated.

	1982 $'S
SAVINGS	
ENERGY	807444
OTHER	201861
TOTAL	1009305
EXPENSES	
GAS	0
ENERGY	86172
OTHER	69925
TOTAL	156097
INITIAL INVESTMENT	6891420

NATURAL GAS

YEAR	WELLHEAD PRICE	ESC. FACTOR	CUM ESC FACTOR	ENERGY @ 6 % CUM ESC FACTOR
1982	1.91	1.00	1.00	1.00
1983	2.09	1.09	1.09	1.06
1984	2.26	1.08	1.18	1.12
1985	3.62	1.60	1.90	1.19
1986	3.83	1.06	2.01	1.26
1987	3.98	1.04	2.08	1.34
1988	4.15	1.04	2.17	1.42
1989	4.31	1.04	2.26	1.50
1990	4.47	1.04	2.34	1.59
				1.69
				1.79
				1.90
				2.01
				2.13
				2.26
				2.40
				2.54
				2.69
				2.85
				3.03

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SIERRA ARMY DEPOT

YEAR	SAVINGS	EXPENSES	NET REV
1982	1009305	156097	853208
1983	1057752	161267	896484
1984	1109105	166748	942357
1985	1163540	172557	990982
1986	1221240	178715	1042525
1987	1282403	185243	1097161
1988	1347236	192162	1155074
1989	1415958	199496	1216462
1990	1488804	207270	1281534
1991	1566021	215511	1350510
1992	1647870	224246	1423624
1993	1734631	233505	1501126
1994	1826597	243320	1583277
1995	1924081	253724	1670357
1996	2027414	264752	1762663
1997	2136948	276441	1860506
1998	2253053	288832	1964221
1999	2376124	301967	2074158
2000	2506580	315889	2190691
2001	2644863	330647	2314216

NPV @ 7%= 6855588

NPV @ 7%	6855588
SIMPLE PAYBACK	6.93
D'CTD PAYBACK	9.32