**Donated By:
Herbert Rogers Jr.
Rogers Engineering Co.**

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SUPPLEMENTAL REPORT

20 MW GEOTHERMAL POWER PLANT
WITH
STEAM GATHERING AND BRINE INJECTION
ROOSEVELT HOT SPRINGS, UTAH

MODIFICATIONS TO STEAM GATHERING
AND
BRINE INJECTION SYSTEMS

Prepared for

UTAH POWER AND LIGHT COMPANY
1407 WEST NORTH TEMPLE
SALT LAKE CITY, UTAH 84110

S-80006-01

AUGUST 1980

ROGERS
Engineering • San Francisco

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111 Pine Street
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E-08-001, Rev. 1	Electrical Single Line Diagram
E-46-102, Rev. 1	Power Plant & Well Field Area Plan

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1.0

INTRODUCTION

Upon review of the cost associated with the design and layout of the steam gathering and brine injection systems as included and evaluated in Rogers' July 1980 Report on the 20 MW Roosevelt Hot Springs, Utah, Utah Power and Light Company (UP&L) determined that certain modifications could be reasonably made in the extent and design of the steam gathering and injection systems which would reduce the costs without seriously jeopardizing the system performance. These modifications were identified and discussed and a preliminary evaluation made on 28 July 1980.

1.1

Purpose

This report presents description of the modifications to the steam gathering and injection systems selected by UP&L and evaluates their effect on the capital cost estimates presented in Rogers' July 1980 Report.

1.2

Scope

The scope of this report is limited to formal identification of the modifications to the steam gathering and injection systems as deter-

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mined by UP&L and described in Section 2.0 and the development of capital cost reductions of these modifications as they apply to the total costs previously estimated. Economic analyses and evaluations of the results are not to be included in this report.

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2.0 SYSTEMS MODIFICATION CRITERIA

Modifications to the steam gathering and injection systems to be evaluated are identified separately by system in the following paragraphs.

2.1 Steam Gathering System

2.1.1 Delete production Well 72-16 from the system.

2.1.2 Use production Wells 54-3, 13-10, A-1, and A-2.

2.1.3 Show the cost reduction for deletion of production Well A-2 separately.

2.2 Injection System

2.2.1 Delete injection Well 25-15.

2.2.2 Use injection Wells 14-2, 12-35, and 82-33 for hot injection system.

2.2.3 Delete the cold injection piping system from the project, i.e., the 5" line connecting surge ponds at the production well sites and

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extending to injection Well 82-33. The cooling tower blowdown is to be connected into the hot injection piping system.

- 2.2.4 Show the cost reduction for deletion of injection Well 82-33 as a separate item.

2.3 Power Plant Relocation

Evaluate the effect of relocating the power plant from the present location indicated on fee land to an area near the location of production Well A-1. Optimization of plant location is not required or included.

2.4 General Design Criteria

- 2.4.1 The same basic design criteria used for the steam gathering and injection systems in the July 1980 Report apply to the design of the system modifications herein.
- 2.4.2 Pipeline layout follows the original systems layouts. Drawing E-46-102, Rev. 1 reflects modifications presented in this report.

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3.0 SUMMARY

3.1 Total Cost Reduction

3.1.1 The total estimated cost reductions in 1980 dollars for the selected modifications to the steam gathering and injection systems is as follows:

Gathering System	\$1,755,000
Injection System	<u>2,285,000</u>
Total Estimated Cost Reduction	\$4,040,000

3.1.2 A summary breakdown of the major elements of the above totals is included in SECTION 5.0. In addition, the cost estimate for the gathering and injection systems as presented in the July 1980 Report has been revised to reflect the cost reductions developed herein and is also included in SECTION 5.0 and reflects 1980 costs and escalation to 1983.

3.2 Steam Gathering System

3.2.1 Power plant operation at rated output will require in excess of two production wells. Reduction of production wells to a total of

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three, Wells 13-10, A-1 and 54-3, could jeopardize the capability of plant to operate at full capacity should one well become inoperative.

- 3.2.2 Total estimated cost reduction for the modifications to the steam gathering system including deletion of Well A-2 is \$1,755,000 in 1980 dollars. Estimated cost reduction for deletion of Well A-2 is \$242,000.

3.3 Injection System

- 3.3.1 Based on the injection rates provided in the basic criteria for the project, reduction of the number of injection wells to two could seriously limit the capability of full capacity operation of the power plant if one injection well should become inoperative.
- 3.3.2 Discharge of cooling tower blowdown into the hot injection system is not likely to reduce the temperature of the hot brine to a low enough level to present an injection problem.
- 3.3.3 Disposal of the cold brine at the surge ponds at each wellhead separator may be possible by controlled bleed into the hot injection

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system as long as the injection temperature level is not reduced to an unacceptable level.

- 3.3.4 The total estimated cost reduction for the modification to the injection system is \$2,285,000 in 1980 dollars. This includes cost reduction of \$593,000 for deletion of piping to Well 82-33 and \$290,000 for surge pond construction inadvertently included in the estimate in the July 1980 Report.

3.4 Power Plant Relocation

Relocation of the power plant from the present location on fee land to a non-fee land location near Well A-1 was evaluated for possible cost reduction. Due to line size changes in the piping required by the revised steam collection system configuration, the net cost differential for the two locations was extremely small leading to the conclusion that the fee land location would probably be a more advantageous site for other reasons than basic costs.

3.5 Qualification

Attention is invited to the fact that final design could negate or modify some of the conclusions presented by this report and analysis, if detail design development discloses other features to be considered.

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4.0

SYSTEM MODIFICATIONS

Modifications to the steam gathering and injection systems as described herein are reflected on the following drawings which are incorporated into this report.

Drawing No. E-02-102, Rev. 1	Steam Gathering & Injection System
Drawing No. E-08-001, Rev. 1	Electrical - Single Line Diagram
Drawing No. E-46-102, Rev. 1	Power Plant and Field Area Plan

4.1

Steam Gathering System

The steam gathering system modifications comprise the following items.

4.1.1 Deletion of production Well 72-16

- (a) Requires deletion of approximately 6,600 feet of 28" diameter insulated pipe between Well 72-16 and Well 13-10 including pipe supports.

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- (b) Reduce pipe size from Well 13-10 to A-1 from 28" diameter to 24" diameter - approximately 3,100 feet.
- (c) If Well A-2 is retained as a production well no other modifications to the piping systems as originally defined will be required.

4.1.2 Deletion of production Well A-2

- (a) If Well A-2 is omitted from the layout, piping from production Well 54-3 would be extended full size (22" diameter) to the power plant location near Well A-1. The cost reduction for this configuration is basically due to reduction in insulated pipe size from 28" diameter to 22" diameter for a distance of approximately 2,600 feet, (Well A-2 to Well A-1) deletion of a well effluent (hot injection) pump requirement and deletion of associated site preparation.

4.2 Injection System

The modifications to the injection system require the following revisions and adjustments to the basic design presented in the July 1980 Report.

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4.2.1 Delete injection Well 25-15 from system

- (a) This modification results in the deletion of 7,900' of 10" diameter insulated pipe and supports extending from Well 25-15 to Well 13-10; plus the deletion of two injection booster pumps for Well 25-15 and one injection pump for Well 72-16; plus site improvement costs associated with pump installation.

4.2.2 Use injection Wells 14-2 and 12-35

This modification results in a requirement to increase the insulated injection piping from 12" diameter to 14" diameter from Well A-2 to 54-3 (2,300 ± feet); plus increase the insulated injection piping from 8" diameter to 12" diameter from Well 54-3 to 12-35 (9,000± feet). These costs will be additive caused by design pressure drop considerations.

4.2.3 Delete the cold injection pipeline discharging to Well 25-15

This modification results in a cost reduction associated with the deletion of a 5" diameter piping system complete with supports extending from Well 72-16 to injection Well 25-15 - approximately 14,000 feet.

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4.2.4 Modifications to Pumping Requirement

Net cost reductions for pumping revisions required by the system modifications consider the following:

- (a) Deletion of two 600 hp booster injection pumps for Well 25-15.
- (b) Deletion of one 300 hp injection pump at Well 72-16.
- (c) An increase of 500 hp total in injection booster pumps for Well 12-35 and Well 14-2.
- (d) A decrease of 7,900' of electric distribution line for pumps removed from service for Well 25-15 and Well 72-16.

4.2.5 Delete piping to Well 82-33

This modification results in a cost reduction for deletion of approximately 7,600 feet of 10" diameter of cold injection piping extending from approximately Well 54-3 to Well 82-33.

4.2.6 Wellhead Surge Ponds

The cost of the wellhead surge ponds had been inadvertently included in the cost estimate as a UP&L cost in the July 1980 Report

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although it was originally considered and is shown in that report as being a steam supplier cost element. The cost for these ponds is deducted in this report.

4.3 Plant Relocation

A preliminary evaluation of the relocation of the 20 MW geothermal plant from its initial position on fee land to an area near production Well A-1 was made to determine possible cost reductions which might obtain. The steam gathering piping system pipe sizes and layout configurations were the salient cost factors involved in the plant relocation.

The new plant location selected is shown on Drawing E-46-102, Rev. 1 and considers access from existing roads, etc.

A comparative analyses of pipe sizes required from Wells A-2 and A-3 to the present location under the new well flow pattern and the pipe size and configuration required for the new location was made and evaluated. The cost for each system proved to be so close to each other that decision making on this basis is precluded.

Since the cost differential is so small, it is probably highly advantageous to leave the plant at the original site location on fee land.

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5.0 COST ESTIMATE

5.1 A breakdown of the estimated net cost deductions in 1980 dollars for the major elements related to selected modifications is as follows:

5.1.1 Gathering System Cost in 1980 \$

(a) Delete Piping from 72-16 to 13-10 including Pipe Size Revision (13-10 to A-1)	\$1,513,000
(b) Delete A-2 from System including Piping, Pumps, and Sitework	242,000
	<hr/>
Total Cost Reduction for Gathering System Modifications	\$1,755,000

5.1.2 Injection System

(a) Delete Well 25-15 Piping Systems	\$ 472,000
(b) Delete Cold Injection Piping System	547,000
(c) Delete Piping to 82-33	593,000
(d) Delete Pumps for 25-16 and 72-16 and Add hp for Pumps 14-2 and 12-35	400,000
(e) Decrease Electric Power Distribution	28,000
(f) Delete Sitework	66,000
(g) Delete Surge Ponds-This is for Steam Suppliers Account. Inadvertently included in previous estimate	290,015
	<hr/>

Total Cost Reduction for Injection
System Modifications \$2,285,000

5.1.3 Total Cost Reduction for Steam Gathering and Injection System Modifications

(a) Steam Gathering System	\$1,755,000
(b) Injection System	<u>2,285,000</u>

Total Estimated Cost Reduction \$4,040,000

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5.2

Revised Cost Estimate

The computer run cost estimate sheets for applicable portions of the original estimate in the July 1980 Report have been revised and are included in this section. These sheets provide costs in 1980 dollars and also include escalated costs to 1983 as in the previous report.

The economic analyses for the total reduced dollar amounts resulting from the modifications evaluated herein was not included in the scope of this report and has not been made.

DG-023

ROGERS ENGINEERING CO., INC.
111 PINE STREET
SAN FRANCISCO, CALIF. 94111
JOB NO. S-80006-0020 MW GEOTHERMAL POWER PLANT
COST ESTIMATE
GATHERING/INJECTION SYSTEMDRAWING NO. REV.
A-01-102 1
SHEET 1 OF 5

GATHERING/INJECTION SYSTEM

GATHERING/INJECTION SYSTEM ROGERS ENGINEERING CO., INC. COST ESTIMATE
JOB NAME-UP&L-20HW JOB NO.-S 80006 CLIENT-UTAH P&L ESTIMATE DATE- AUG 1980

ITEM NO. DESCRIPTION MATL&EQPT INSTALL MANHOURS TOTAL ESC TOT

ESTIMATE SUMMARY

ESTIMATE TOTAL 2093837. 1360818. 49026. 3454655.

MATERIAL ESCALATION 391632.

LABOR ESCALATION 284139.

SUBTOTAL W/ ESCALATION 2485469. 1644957. 675770.

INSTALLED COST WITH ESCALATION 4130426.

INTEREST DURING CONSTRUCTION 702222.

TOTAL PROJECT COST W/O ACCOUNT 399 4832648.

TOTAL ACCOUNT 399 222000.

TOTAL PROJECT COST INCL. ACCOUNT 399 5054648.

DG-023

JOB NO. S-80006-00

111 PINE STREET
SAN FRANCISCO, CALIF. 9411120 MW GEOTHERMAL POWER PLANT
COST ESTIMATE
GATHERING/INJECTION SYSTEM

ROGERS ENGINEERING CO., INC.

GATHERING/INJECTION SYSTEM

ROGERS ENGINEERING CO., INC.

COST ESTIMATE

GATHERING/INJECTION SYSTEM

JOB NAME-UP&L-20HW

JOB NO.-S 80006

CLIENT-UTAH P&L

ESTIMATE DATE- AUG 1980

1980

1983

ITEM NO.	DESCRIPTION	MATL&EQT	INSTALL	MANHOURS	TOTAL	ESC TOT
312.1	GATHERING SYSTEM	0.	0.	0.	0.	0.
312.1.1	PIPELINE HDR+MISC	77240.	96561.	3429.	173801.	204493.
312.1.2	PIPING-C.S.-A53	144825.	308972.	10972.	453797.	534464.
312.1.3	VALVES&FITTINGS	164135.	38607.	1371.	202742.	238952.
312.1.4	INSTRUMENTATION	15448.	3936.	141.	19384.	23512.
312.1.5	INSULATION	77240.	74829.	2743.	152069.	178834.
312.1.6	SUPPORTS(PIPE)	38620.	38628.	1416.	77248.	92676.
312.1.7	SITE IMPROVEMENTS	40000.	120005.	4399.	160005.	198923.
312.2	INJECTION SYSTEM	0.	0.	0.	0.	0.
312.2.1	PLANT PIPING&PUMPS	97506.	48548.	1724.	146054.	171543.
312.2.2	PIPING-C.S.-A53	121787.	195008.	6925.	316795.	372917.
312.2.3	VALVES&FITTINGS	280377.	36411.	1293.	316788.	372465.
312.2.4	INSTRUMENTATION	9864.	2556.	83.	12420.	15067.
312.2.5	INSULATION	12141.	12137.	431.	24278.	28553.
312.2.6	SUPPORTS(PIPE)	48943.	52350.	1919.	101293.	121458.
312.2.7	SITE IMPROVEMENTS	83711.	332270.	12180.	415981.	491947.
312.2.9	SYS.BOOSTER PUMPS	860000.	0.	0.	860000.	1031623.
312.2.10	4.16KV DISTR.LINES	22000.	0.	0.	22000.	27239.
ACCOUNT TOTAL		2093837.	1360818.	49026.	3454655.	4094666.

DRAWING NO.

A-01-102

1

SHEET 4 OF 5

[illegible]

NOTES:

1. SEE DWG 2- FOR LOCATIONS OF WALLS.

2. CURRENT LIMITING FUSES IN 4.16 KV SWGR SHALL BE SIZED TO SUIT MOTOR HORSEPOWER OF TRANSFORMER FULL LOAD AMPERES.

<div> <div> ROBERTS ENGINEERING CO., INC. <small>ENGINEERS & ARCHITECTS 100 WEST CENTER, SUITE 200, SALT LAKE CITY, UTAH 84111</small> </div> <div> UTAH POWER & LIGHT COMPANY <small>DATE: 7-8-80</small> </div> </div>				20 MW GEOTHERMAL POWER PLANT ELECTRICAL SINGLE LINE DIAGRAM																									
<div> <div> <small>REV. FOR SUPP. REPORT</small> <small>DESIGNED FOR PRELIMINARY DESIGN</small> </div> <div> <small>SCALE: AS SHOWN</small> <small>DATE: 7-8-80</small> </div> </div>				<small>APPROVED</small> <small>DATE</small>	<small>NO. 1</small> E-08-001 <small>REV. 1</small>																								
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