QUARTERLY TECHNICAL REPORT

7 JAN. 1981 - 30 APR. 1981

STUDY OF RESOURCE, ENGINEERING AND
ECONOMIC ANALYSIS OF A GEOTHERMAL FUEL
ALCOHOL PRODUCTION PLANT AT VALE, OREGON

Stephen M. Munson
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Glenn Selch
A.B. Baardson
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20 May 1981

Work Performed Under Cooperative Agreement
No. DOE-FC07-81ID 12191
for the
Idaho Operations Office

RENEWABLE ENERGY, INC.
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Denver, CO 80203

U. S. DEPARTMENT OF ENERGY
Geothermal Energy

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ABSTRACT

This report covers the first four months of work on DOE Cooperative Agreement No. DE-FC07-81ID12191, entitled "Study of Resource Engineering and Economic Analysis of a Geothermal Fuel Alcohol Production Plant at Vale, Oregon".

The Contractor-funded portion of the Cooperative Agreement includes the costs associated with the drilling of a "production size" geothermal well hole for testing and extraction of the hydrothermal fluid.

Raw data are not included with this report because the data collected have not yet been evaluated, as is more fully described herein. Raw data of this sort collected but not included are geochemical sample analyses and feedstock surveys.

Preliminary geothermal fuel alcohol plant process flow, plant layout and instrumentation drawings are included and attached in the Appendix to this report.

This report enumerates the accomplishments completed by the end of this report period which was April 30, 1981.

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I. INTRODUCTION

This report covers the first four months of work on DOE Cooperative Agreement No. DE-FC07-81ID12191, entitled "Study of Resource Engineering and Economic Analysis of a Geothermal Fuel Alcohol Production Plant at Vale, Oregon".

This program was undertaken by Renewable Energy, Inc. "REI", (formerly Technology International, Inc.), as the first significant step in utilizing the renewable geothermal heat believed to be available under land leased to REI with the ultimate objective of constructing a Geothermal Fuel Alcohol "Gasohol" plant on the Geothermal Industrial Park "GeoPark" site.

REI has previously developed designs for energy efficient plants for production of anhydrous ethanol for fuel. Under this program, these designs will be adapted to the use of hydrothermal energy of the quality thought to be available from the Vale prospect and detailed design, cost and economic trade-offs will be evaluated.

The work to date is reported herein by Task. The five major Tasks are:

- Task 1: Geothermal Resource Assessment
- Task 2: Testing, Marketing and Economic Analysis
- Task 3: Site, Specific Geothermal Application
Feasibility
- Task 4: Environmental and Safety
- Task 5: Legal and Institutional

Significant efforts were devoted to Tasks 1, 2, 3 & 4, while work on Task 5 is scheduled later in the program. None of the first four tasks was completed during the reporting period.

The Contractor-funded portion of the Cooperative Agreement includes the costs associated with the drilling of a "production size" geothermal well hole for testing and extraction of the hydrothermal fluid.

Raw data are not included with this report because the data collected have not yet been evaluated, as is

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Preliminary geothermal fuel alcohol plant process flow, plant layout and instrumentation drawings are included and attached in the Appendix to this report.

This report enumerates the accomplishments completed by the end of this report period which was April 30, 1981.

II. SUMMARY

During the first quarterly reporting period, substantial progress was made on the scheduled tasks.

Task 1, the most critical effort to succeeding objectives, is well ahead of schedule. Data collected under the geoscientific task includes surface geology, geochemical survey, sampling and chemical analysis, magnetometer survey, gravimetric survey and temperature gradient survey.

Tasks 2,3 and 4 were slightly behind the original schedule in terms of concluded evaluations due to contract and startup problems elsewhere described. However, related data collection and preliminary engineering are of good quality in the opinion of project management. Based upon the very preliminary analysis available, it is presently considered probable that a favorable conclusion will be reached regarding the feasibility of the proposed five million gallon per year geothermal fuel alcohol plant.

III. STUDY OBJECTIVES.

The objectives of this proposed study are as follows:

1. Carry out a geoscientific study to determine the best location for drilling a production-size exploration hole on proposer leasehold in Vale KGRA near Vale, Oregon. This includes geological, geochemical and thermal gradient drilling activities.
2. Drill a production-size exploration hole to about 1500 foot depth where geothermal fluids at a temperature adequate for the needs of an alcohol plant may be expected. To be drilled and tested with proposer funds.
3. Carry out reservoir testing, as well as chemical and engineering (corrosivity and scaling) evaluation of the exploration well.
4. Complete the site specific design of a 5,000,000 gallon-per-year alcohol plant after taking into account the quality and quantity of the produced geothermal fluid and factors listed in 5. below.
5. Conduct testing, marketing and economic study program of feedstocks, byproduct feeds, managed by Portland State personnel, and locate new and potential distributors of the produced alcohol. Study includes evolution of various economic tradeoffs.
6. Continue and complete legal reviews associated with licensing of the fuel alcohol plant and review Oregon Geothermal Heating District legislation to facilitate possible tie-in for Vale.
7. Complete an environmental assessment for both the geothermal fluid production and disposal, as well as for the ethanol plant.
8. Complete a socio-environmental assessment and

action plan.

9. Design of fluid transmission and disposal system for the geothermal fluid and a geothermal byproduct feed drying system.
10. Produce a Final Report which will be beneficial to other site specific fuel alcohol plant replication projects in other areas with differing resource and agricultural characteristics.

IV. TECHNICAL RESULTS

A. Task 1: Geothermal Resource Assessment

Professional exploration staff of Renewable Energy, Inc. has been assigned to work under the immediate direction of Dr. Tsvi Meidav on relevant portions of the resource assessment package. To date, most of the field work has been accomplished, but data reduction is not finished in most instances. The exploration team has completed the preliminary data survey, geochemical sampling, magnetometer survey, gravimeter survey (site surveying now being completed), temperature gradient hole program and surface geology. You may note that some of this work exceeds the work agreed to under the PRDA.

As a separate matter, the company drilled a small exploration hole on the lease near the hot springs. A steam discovery was made which information was carried in the local newspapers.

The relatively small amount of data reduction completed by cutoff date for this report is contained in the section completed by the task leader, Dr. Meidav. This section follows.

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Vale, Oregon Geothermal Project

Geoscientific Investigations

Introduction

Because of the late start of the project, due to contract formalities, most of the work in the first quarter of this project consisted of data gathering. The gathered data was in the areas of geology, geochemistry and geophysics.

Geology

We have obtained aerial photos for the Vale area. These have been analyzed in a preliminary fashion with the aid of stereo pairs. The preliminary examination shows that the faulting pattern within the Rhinehart Buttes is far more complex than that which would be inferred from the existing geologic maps. It appears that the Buttes, themselves a horst, contain one or more grabens within them. The lineaments suggest that cross-faulting occurs in the area, which may be related to the preferential paths of thermal fluid migration.

The project hired John Doerr, a graduate student in the geology department at the University of Portland. Mr. Doerr's responsibility would be to prepare a precise structural and stratigraphic map of the project site, as part of his work towards a Master's degree in geology. As a consequence of Doerr's study, we expect to obtain the following data:

1. Location of faults in the project site, the amount of relative movement, if determinable, and the relative age of movements;
2. Precise description of the stratigraphy of the formations which underlie the area, based upon exposures on the horst blocks and the available well logs for the surrounding area.

Geochemistry

The geochemical survey consisted of the collection of about 30 water samples for the study of the local hydrogeology and for a better estimate of reservoir temperature. By determining the chemical composition of large water bodies, such as the Malheur River or that of the cold water, it is possible to estimate the

the degree of mixing of the undiluted reservoir water with the shallow cold water during the upward travel of the hot water. The warm springs are probably an expression of such a mixing. A number of techniques exist for the calculation of the true reservoir temperature, if the chemistry and temperature of the cold and of the diluted warm water is known. From these, it may be possible to obtain a better estimate of the true reservoir temperature. In many, but not all cases, the true reservoir temperature turns out to be higher than that calculated from single-spring chemical geothermometry.

Another objective of the hydrogeochemical survey is to establish the local directions of subsurface water flow, if possible. This would be useful in estimating the recharge capacity of the reservoir, and may provide further insights as to the direction of migration of hot water in the subsurface.

The samples were filtered in the field. Some key samples were acidified to a pH of 2-3. All samples were analyzed for the following quantities or constituents: pH, Na, Ca, Mg, Cl, SiO₂, B, As, HCO₃, SO₄, CO₃, F, K, Li. The results of the chemical analyses have been returned by the laboratory, and are now ready for further processing. Geochemical temperatures will be calculated. Various iso-salinity maps will be prepared. These maps will serve as the basis for the interpretation which will follow. A summary of the geochemical data is given in Appendix 1.

Thermal Gradient Survey

A total of 4 thermal gradient holes have been drilled on the REI lease, to a usable depth range of 200' to 300'. One hole, TG4, collapsed before casing was inserted, and hence is not included in the total (Figure 1).

The holes have been drilled with a 6" bit, and cased with a 1.5" PVC liner which was then filled with water. Measurements were taken with an Envirolab thermistor cable and checked against a maximum thermometer which was attached to the cable. A consistent difference of up to 1.7°C was noted between the thermistor cable and the thermometer. While this is a rather large difference, its effect on the gradient calculation is quite small.

The temperature gradients vary from 7.5°F/100' to 35.6°F/100'. These gradients are generally indicative of a convective system at depth, and hence are not expected to extend linearly to a very great depth. However, the steepness of the gradients corroborates our early assumption of a relatively shallow depth to the cap of the reservoir, which may be about 1500' at its shallowest. The actual depth required for production drilling will depend upon the

combination of temperature and the thickness-permeability product which would permit adequate productivity.

Other Geophysical Surveys

Although our proposal to the DOE does not include the execution of other surveys, we have carried out, on our own, ground magnetometer and gravity surveys. The purpose of these surveys is to define as well as possible the geological structure, and especially the major faults in the area. Additionally, we wish to estimate the thickness of the low-density, low-permeability members of the Deer Butte and Chalk Butte formations. The reason for that is that it may be required to drill below these silty formations to encounter adequate permeability.

The ground magnetometer survey covered six traverses which spanned across the Rhinehardt Buttes and into the plains north and west. Three of these traverses were oriented east-westerly, and three in the north-south direction. Because of the case of magnetometer reading, stations were occupied every 100' along the traverses. A Scintrex one-gamma, total field, nuclear precession magnetometer was employed. Base station readings were taken about every two hours to correct for drift. The gravity survey utilized a LaCoste -Romberg model D gravimeter, with a theoretical precision of plus-minus one microgal. Readings were taken every 250' along traverses, and at greater separations in the surrounding plains.

The magnetometer is being currently reduced and contoured, in preparation for a detailed analysis. The gravity data reduction must await the completion of surveying the precise altitude and location of each station, which will be carried out in the latter part of May, 1981.

General Observations

The field work has progressed as smoothly as could be hoped for, and all field work objectives so far have been attained. The temperature gradient data corroborates our early expectation that a high temperature zone is locatable below the lease area at a relatively shallow depth. The combination of the chemical data and the geophysical surveys should help us in better estimating the reservoir temperature and the geological structure and stratigraphy at the project site.

B. Task 2: Testing, Marketing and Economic Analysis

During the initial quarter, the data gathering was almost completed. Most of the potential feedstock has been tested, although some results are not yet in. Since all testing has not yet been completed, it is not yet appropriate to offer comparative evaluations.

Based upon preliminary evaluation, it does appear that one of the classes of potato waste tested may be of sufficiently high starch content to be used as feedstock. Another class of potato waste is too low in available starch to be of interest. The possibility of utilizing onion waste has been discounted due to its lack of sufficient starch content. Corn, barley, wheat and sugar beets all show good potential. At a separate site, the project manager is raising fodder beets and sweet sorgham for later evaluations.

Several field surveys have been completed by staff personnel directed at test sample collection, economic data collection for input and output markets and eventual economic analyses. A purchase order for project work has been sent to the Northwest Energy Policy Workshop associated with Portland State University. The work is primarily related to the marketing and economic analysis which was originally scheduled to be carried out by Oregon State University.

A computer based economic analysis model is now being programmed. The model will cover all major costs and expenses associated with the proposed plant. Sensitivity analyses will be possible and assumptions may be varied, including price of feedstock through transportation costs, geothermal field costs, plant capital costs and assumed operating costs. It will be capable of offering significant insight into the economics of fuel alcohol plant operations assuming a geothermal fuel source.

Preliminary evaluation of feedstock markets indicates sufficient cropland within transportable distance to supply a plant of the proposed size without unduly driving up the price of the available feedstock. This evaluation will be refined through use of the

model.

C. Task 3: Site Specific Geothermal Application Feasibility

1. General: Task 3 includes five Sub-Tasks:

- Sub-Task 3.1: Site Specific Microbiological Adaptation
- Sub-Task 3.2: Site Specific Production Plant Adaptation
- Sub-Task 3.3: Geothermal Delivery System Design
- Sub-Task 3.4: Heat Exchangers and User Equipment Design
- Sub-Task 3.5: Geothermal Drying System

The preliminary engineering accomplished during this reporting period is applicable to Sub-Tasks 3.2, 3.3, 3.4 and 3.5 with the most emphasis on 3.2 and 3.4. For the purposes of this report, the work is generally described rather than specifically because of the present status of work completed.

2. Flow Sheet Adaptation: Basic ethanol production process flow sheets from previous REI work were revised to reflect the use of geothermal hot water/low pressure steam as the energy source rather than the high pressure steam around which fuel burning plants are designed. The exact configuration of heat exchange systems is not finally established pending acquisition of more chemical, thermal and capacity data from the geothermal exploration program.

Based upon very preliminary exploration results, it appears quite possible that the property may be capable of electrical generation temperature ranges. Any such electrical generation projects, even if electrical energy were used by the gasohol plant, will not be included in this project. However, even though engineering for such electrical generation plant is not part of this project, certain geothermal flow rate assumptions do make allowance for the possible existence of such a plant.

Tentative flow sheet configurations are based on the assumption that hot water at approximately 180°C (356°F) will be available at a flow rate of approximately $2.30 \times 10^{-2} \text{ m}^3/\text{sec}$ (365 gal/min). A portion of this flow will be used to generate electricity via dual flashed steam through a two stage turbine-generator. The process heat requirements will be met by use of high temperature water through indirect heat exchangers for high temperature loads such as cooking, first stage distillation, by-product drying and/or first stage evaporation; low pressure flashed steam for direct steam injection into low temperature loads such as preheating and alternate lower temperature distillation and low temperature water from flashing for indirect heat exchange on low temperature loads, perhaps to include use in a geothermal space heating district.

If lower temperatures or higher chemical impurities than expected are found, then one or more of the following alternate steps may be necessary:

- a) Modification of the cooking process to allow lower temperature operation. This primarily involves longer residence times - possibly to the point of dictating batch rather than continuous cooking,
- b) Use of more corrosion resistant alloys in heat exchangers (no change in process flow required),
- c) Use of plate heat exchangers in place of spiral plate and shell and tube heat exchangers to facilitate scale removal (probably no change in process flow required),
- d) Use of plate heat exchangers in conjunction with secondary clean water heat transfer loops to segregate geothermal water from process heat exchangers, and/or
- e) Use of binary fluid direct heat exchange to generate pressurized organic vapor for operation of the turbine-generator.

3. Process and Instrumentation Diagrams (P&ID's): Three sheets of P&ID's have been nearly completed. These cover the Cooking and Conversion, Fermentation, and Distillation process steps. Included with these are the major equipment schedules, instrumentation schedules and control valve schedules. Please refer to the Appendix.

The instrumentation and control concept reflected in these P&ID's is maximum automation and control using available technology without entailing totally unreasonable costs. It is anticipated that the instrumentation and control will be somewhat reduced upon economic analysis of the capital cost of two or three levels of automation versus life cycle costing of the plant operation.

4. Plant Arrangement Drawings: An overall plant plot plan was prepared to allow cost estimation of land, site work, roads and rail siding, outside structures and buildings. Please refer to the Appendix.

An aerial perspective view of the plant site was prepared to allow better visualization of the aesthetic features of the plant for environmental evaluation and for use in anticipated future news releases and financing proposals. Please refer to the Appendix.

5. Alternate Feedstock Provisions: Pending completion of Task 2, the storage facility and process designs will be only tentative because of the possibility of various feedstock mixes. Currently, it is envisioned that the principal feedstocks will be corn, sugar beets and cull potatoes. Other, minor feedstocks are possible.

The selection of feedstocks and a knowledge of the quantities available and seasonal nature of each affects the design of transportation facilities, storage facilities, feedstock preparation equipment, cooking and conversion processes, by-product processes and by-product storage facilities. To a lesser extent, the detailed design of fermentation and distillation equipment will be affected.

D. Task 4: Environmental and Safety

Dr. Tsvi Meidav is in receipt of the flora and fauna report prepared for him by subcontractors and is now somewhat tardy in completion of the required Environmental Evaluation Report. That report will be forwarded to you upon its completion. Dr. Meidav has agreed to complete the report immediately.

The safety portion of the project will be primarily a hazard analysis for the proposed plant. The analysis will be started after the engineering work has been completed.

E. Task 5: Legal and Institutional

After getting underway with the project, it was decided to carry out this task later for two reasons:

1. We will have an overview of the entire sequence of institutional effects experienced by the project to that date, and will, therefore, be in a position to fully identify various institutional constraints and offer a historical view of institutional operations and socio-economic barriers, and

2. The legal situation is continually changing and a "picture" of certain legal items near the close of the project will be more helpful than one at the start.

V. FUTURE WORK

During the next quarterly reporting period, the following work is planned:

- A. Task 1: The data collected during the survey phase will be reduced and evaluated. Other exploration well activities will be completed.
- B. Task 2: Feedstock evaluations will be completed and computer economic sensitivity analysis will be carried out using model now being programmed.
- C. Task 3: The preliminary engineering activity

will be completed to include:

- 1) Pipe sizing and scheduling,
- 2) Instrumentation and control schedules completed, data sheets for each item completed and prices obtained,
- 3) Levels of automation defined and priced,
- 4) Major equipment prices obtained.

- D. Task 4: The Environmental Evaluation Report is being completed now.
- E. Task 5: Work on this task is now scheduled for the final quarter of the project.

APPENDICES

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EQUIPMENT DESIGNATIONS

C	U-Tube Cooker
DC	Distillation Column
DT	Decanter Tank
F	Fermentor
EL	Elevator Leg
FL	Filter
HC	Hydro Clone
HX	Heat Exchanger
P	Pump
RJ	Rotary Jet Cleaner
SB	Storage Bin
SC	Screw Conveyor
SM	Steam Mixer
T	Tank
WS	Weigh System

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ABBREVIATIONS

CWR	Cooling Water Return
CW	Cooling Water
Geo HW	Geothermal Hot Water
HWR	Hot Water Return
STM	Steam

L E G E N D

EQUIPMENT DESIGNATOR
INSTRUMENTATION DESIGNATOR
PIPELINE DESIGNATOR
MICROPROCESSOR ANALOG INPUT
MICROPROCESSOR ANALOG OUTPUT
MICROPROCESSOR CONTACT CLOSURE INPUT
MICROPROCESSOR CONTACT CLOSURE OUTPUT
MANUALLY OPERATED BALL VALVE, NORMALLY OPEN
MANUALLY OPERATED BALL VALVE, NORMALLY CLOSED
AIR OPERATED MODULATION VALVE
PRESSURE REGULATING VALVE - INTERNAL PILOT
CONTROL VALVE, NORMALLY OPEN
CONTROL VALVE, NORMALLY CLOSED
NORMALLY OPEN VALVE
NORMALLY CLOSED VALVE
PINCH OR DIAPHRAM VALVE, NORMALLY OPEN
PINCH OR DIAPHRAM VALVE, NORMALLY CLOSED
CHECK VALVE
MANUALLY OPERATED BUTTERFLY VALVE

L E G E N D (Con't)

THERMOSTATIC OR THERMODYNAMIC STEAM TRAP

FLOAT & THERMOSTATIC TRAP

FLAME ARRESTOR VENT

RUPTURE DISK

VENT

SAMPLING VALVE

VARIABLE SPEED MOTOR CONTROL

MAIN PROCESS PIPING

SECONDARY PROCESS PIPING

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INSTRUMENT DESIGNATIONS

DPT	Differential Pressure Transmitter
FT	Flow Sensor/Transmitter
IT	Current (Amperage) Transmitter
ILS	Interface Level Switch
ILT	Interface Level Detector/Transmitter
LS	Level Switch
LT	Level (Liquid) Detector/Transmitter
pHt	pH Transmitter
PI	Pressure Indicator
PT	Pressure Transmitter
RIT	Refractive Index Transmitter
SG	Sight Glass
SGT	Specific Gravity Transmitter
TI	Temperature Indicator
TT	Temperature Transmitter
WT	Weight Transmitter

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INSTRUMENTATION SCHEDULE - 200 SERIES
DRAWING NO. VALE 106

CODE	DW LOC	FUNCTION	MEDIA	TYPE	RANGE	REMARKS
TT-224	G-3	Temp.Trans.				
TT-225	G-3	Temp.Trans.				
TT-227	F-2	Temp.Trans.				
TT-229	B-3	Temp.Trans.				
PT-213	F-5	Press.Trans.				
PT-215	E-5	Press.Trans.				
PT-219	E-4	Press.Trans.				
DPT-212	F-5	Dif.Pres.Tran.				
SG-211	F-5	Sight Glass				
PS-201	G-8	Press.Switch				
PS-205	G-7	Press.Switch				
PS-226	G-3	Press.Switch				
WT-202	E-8	Weight Trans.				
LS-203	D-8	Level Switch				
LS-206	D-7	Level Switch				
LS-207	D-6	Level Switch				
LS-214	F-5	Level Switch				
LS-223	E-3	Level Switch				
LS-228	C-3	Level Switch				
LS-230	B-3	Level Switch				
IT-204	E-7	Cur.Amp.Trans.				
TT-208	G-6	Temp.Trans.				
TT-209	F-6	Temp.Trans.				
TT-210	F-5	Temp.Trans.				
TT-216	H-5	Temp.Trans.				
TT-217	H-4	Temp.Trans.				
TT-218	G-4	Temp.Trans.				
TT-220	G-3	Temp.Trans.				
TT-221	F-3	Temp.Trans.				
TT-222	E-3	Temp.Trans.				

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INSTRUMENTATION SCHEDULE - 200 SERIES
DRAWING NO. VALE 107

<u>CODE</u>	<u>DW LOC</u>	<u>FUNCTION</u>	<u>MEDIA TYPE</u>	<u>RANGE</u>	<u>REMARKS</u>
TT-231	B-5	Temp.Trans.			
TT-232	D-4	Temp.Trans.			
RIT-233	E-2	Refr.Ind.Trn.			
SGT	E-2	Spec.Grav.Trn.			
pHT	E-2	pH.Trans.			

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INSTRUMENTATION SCHEDULE - 300 SERIES
DRAWING NO. VALE 105

<u>CODE</u>	<u>DW LOC</u>	<u>FUNCTION</u>	<u>MEDIA</u>	<u>TYPE</u>	<u>RANGE</u>	<u>REMARKS</u>
FT-301	H-8	Flow Trans.				
FT-309	H-7	Flow Trans.				
FT-310	H-7	Flow Trans.				
FT-334	F-3	Flow Trans.				
FT-337	G-3	Flow Trans.				
TI-302	G-8	Temp. Indic.				
TI-315	G-6	Temp. Indic.				
TI-318	H-6	Temp. Indic.				
TI-319	G-6	Temp. Indic.				
TI-341	E-3	Temp. Indic.				
TI-342	F-3	Temp. Indic.				
PT-303	F-8	Press. Trans.				
PT-313	G-6	Press. Trans.				
PT-325	C-6	Press. Trans.				
PT-344	F-2	Press. Trans.				
PI-304	F-8	Press. Indic.				
PI-316	G-6	Press. Indic.				
PI-343	F-2	Press. Indic.				
TT-305	F-7	Temp. Trans.				
TT-308	H-7	Temp. Trans.				
TT-311	H-7	Temp. Trans.				
TT-312	G-7	Temp. Trans.				
TT-317	H-6	Temp. Trans.				
TT-321	E-6	Temp. Trans.				
TT-322	E-6	Temp. Trans.				
TT-323	D-6	Temp. Trans.				
TT-324	C-6	Temp. Trans.				
TT-328	D-5	Temp. Trans.				
TT-329	E-5	Temp. Trans.				
TT-340	E-3	Temp. Trans.				
TT-345	F-2	Temp. Trans.				
TT-347	D-2	Temp. Trans.				
TT-348	E-2	Temp. Trans.				
TT-350	F-2	Temp. Trans.				
TT-351	H-2	Temp. Trans.				

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CODE	DW LOC	FUNCTION	MEDIA	TYPE	RANGE	REMARKS
SG-306	G-7	Sight Glass				
SG-331	E-4	Sight Glass				
SG-332	G-4	Sight Glass				
SG-335	F-4	Sight Glass				
SG-354	G-1	Sight Glass				
SG-355	G-1	Sight Glass				
SG-356	G-1	Sight Glass				
SG-360	E-1	Sight Glass				
DPT-307	G-7	Dif.Press.Trans.				
DPT-320	G-5	Dif.Press.Trans.				
DPT-326	C-6	Dif.Press.Trans.				
DPT-327	E-6	Dif.Press.Trans.				
DPT-333	G-4	Dif.Press.Trans.				
DPT-338	E-3	Dif.Press.Trans.				
DPT-339	C-3	Dif.Press.Trans.				
DPT-349	E-2	Dif.Press.Trans.				
DPT-352	E-2	Dif.Press.Trans.				
DPT-353	D-2	Dif.Press.Trans.				
LT-314	G-7	Level Trans.				
LT-358	F-1	Level Trans.				
ILT-330	E-4	Intrf.Lev.Tran.				
ILS-336	E-4	Intrf.Lev.Swit.				
ILS-359	G-1	Intrf.Lev.Swit.				
LS-346	E-2	Level Switch				
LS-357	E-1	Level Switch				

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7 Jan. 1981-30 Apr. 1981
Renewable Energy, Inc.

VALVE DESIGNATIONS

A	Air Actuated On-Off Valve
BPCV	Back Pressure Control Valve
CV	Control Valve
FA	Flame Arrestor
FCR	Flow Control Regulator
PR	Pressure Regulator
R	Rupture Disk
S	Solenoid Actuated On-Off Valve
T	Trap

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AUTOMATIC VALVE SCHEDULE - 200 SERIES

DRAWING NO. VALE 106

CODE	DW LOC	FUNCTION	MEDIA	TYPE	RANGE	REMARKS
S-201	G-7	Sol.Act./				
S-214	E-3	Sol.Act./				
S-218	G-2	Sol.Act./				
S-221	D-3	Sol.Act./				
S-223	B-3	Sol.Act./				
S-225	C-2	Sol.Act./				
CV-202	F-7	Cont.Val.				
CV-206	G-6	Cont.Val.				
CV-210	H-5	Cont.Val.				
CV-211	H-4	Cont.Val.				
CV-215	F-3	Cont.Val.				
A-204	F-6	Air Act./				
A-207	F-5	Air Act./				
A-212	D-4	Air Act./				
A-219	D-2	Air Act./				
A-220	D-2	Air Act./				
A-222	C-2	Air Act./				
A-224	B-2	Air Act./				
PR-205	F-6	Pres.Relf.				
BPCV-209	F-5	Bk.Pres.				
		Cont.Val.				
BPCV-243	F-5	Bk.Pres Cont.Val.				
BPCV-243	F-5	Bk.Pres.				
		Cont.Val.				
FCR-216	F-3	Fl.Cont.				
		Regl.				
R-203	F-6	Rupt.Disk				
R-208	F-5	Rupt.Disk				
R-213	D-4	Rupt.Disk				
R-217	G-3	Rupt.Disk				

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AUTOMATIC VALVE SCHEDULE - SERIES 200
DRAWING NO. VALE 107

<u>CODE</u>	<u>DW LOC</u>	<u>FUNCTION</u>	<u>MEDIA</u>	<u>TYPE</u>	<u>RANGE</u>	<u>REMARKS</u>
S-226	G-7	Sol.Act./				
S-235	B-6	Sol.Act./				
S-237	B-5	Sol.Act./				
S-242	E-3	Sol.Act./				
A-227	G-7	Air Act./				
A-228	G-7	Air Act./				
A-230	G-6	Air Act./				
A-231	G-5	Air Act./				
A-232	G-5	Air Act./				
A-234	C-6	Air Act./				
A-238	B-5	Air Act./				
A-239	C-5	Air Act./				
A-240	G-3	Air Act./				
A-241	E-3	Air Act./				
DCV-229	F-6	Dir.Cont.Vl.				
CV-233	D-6	Cont.Val.				
CV-236	B-6	Contr.Val.				

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AUTOMATIC VALVE SCHEDULE - SERIES 300
DRAWING NO. VALE 105

CODE	DW LOC	FUNCTION	MEDIA TYPE	RANGE	REMARKS
BPCV-301	G-8	Bk.Pres. Cont.Val.			
BPCV-303	E-8	Bk.Pres. Cont.Val.			
FCR-302	G-8	Fl.Cont.Reg.			
FCR-318	F-3	Fl.Cont.Reg.			
FCR-324	G-2	Fl.Cont.Reg.			
FCR-328	F-1	Fl.Cont.Reg.			
CV-304	F-7	Contr.Val.			
CV-305	H-8	Contr.Val.			
CV-307	G-6	Contr.Val.			
CV-308	G-5	Contr.Val.			
CV-311	F-5	Contr.Val.			
CV-312	E-5	Contr.Val.			
CV-313	E-5	Contr.Val.			
CV-319	H-3	Contr.Val.			
CV-320	F-3	Contr.Val.			
CV-321	E-3	Contr.Val.			
CV-323	F-2	Contr.Val.			
CV-325	H-2	Contr.Val.			
CV-326	G-1	Contr.Val.			
CV-329	G-1	Contr.Val.			
CV-330	G-1	Contr.Val.			
A-306	G-7	Air Act./			
A-327	F-1	Air Act./			
S-309	G-5	Sol.Act.			
S-314	H-4	Sol.Act.			
S-315	H-4	Sol.Act.			
S-316	H-4	Sol.Act.			
S-317	F-4	Sol.Act.			
S-322	E-2	Sol.Act.			
PR-310	G-5	Pres.Rel. Val.			
R-337	G-8	Rupt.Disk			
R-338	E-3	Rupt.Disk			

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CODE	DW LOC	FUNCTION	MEDIA	TYPE	RANGE	REMARKS
FA-331	F-1	Flame Arre.				
FA-332	D-1	Flame Arre.				
FA-333	F-4	Flame Arre.				
FA-334	B-4	Flame Arre.				
FA-335	B-4	Flame Arre.				
FA-336	E-8	Flame Arre.

VALE GEOTHERMAL GASOHOL PLANT

Annual Capacity: 5,000,000 Gallons Anhydrous Alcohol

TO BE OWNED BY: Geothermal Gasohol, Inc.

An Oregon Corporation

RENEWABLE ENERGY, Inc.

1009 Grant Street Suite 303 Denver, CO 80203
Telephone (303) 832-8215

Scale 1" = 30 feet Approved Date 5/11/81 Dwn By 245

VALE GEOTHERMAL GASOHOL PLANT SITE PLAN

DOW COOPERATIVE AGREEMENT No. DE-FC07-810-12151 Dwg. No. VALE-101

VALE GEOTHERMAL GASOHOL PLANT

Annual Capacity: 5,000,000 Gallons Anhydrous Alcohol

TO BE OWNED BY: Geothermal Gasohol, Inc.

An Oregon Corporation

RENEWABLE ENERGY, Inc.

1069 Grant Street Suite 303 Denver, CO 80203
Telephone: (303) 832-8215

Sketch: NONE	Approved:	Drn. By: JAP
Date: 14-May-81		
VALE GEOTHERMAL GASOHOL PLANT		
ARTIST'S CONCEPTION		
DOE COOPERATIVE AGREEMENT		
No. - DE - 1-07 - 81D 12191	Dwg. No.	VALE-102

RENEWABLE ENERGY, Inc.

1009 Grant Street, Suite 303, Denver, CO 80203
Telephone (303) 837-8215

Scale: NONE	Approved:	Des. By: DB
Date: 14 May 81		
VALE GEOTHERMAL GASOLIN PLANT BYPRODUCT PROCESSING		
DOL COOPERATIVE AGREEMENT No. DE FC07 84D 12191		Dwg. No. VALE-104

RENEWABLE ENERGY, Inc.		
1009 Grant Street Suite 303 Denver, CO 80203 Telephone: (303) 832-8215		
Scale: <i>N.T.</i>	Approved: _____	Drn. By: <i>DAI</i>
Date: <i>11/11/81</i>		
DESIGN: COOKING AND LEAVENING		
USE: COOKING AND LEAVENING		Dwg. No. <i>VAL-100</i>