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**DIRECT USE GEOTHERMAL PON AND PRDA
PROJECTS UNDER DOE-ID ADMINISTRATION**

Annual Report Fiscal Year 1983

October 1, 1982 - September 30, 1983

Prepared by
EG&G Idaho, Inc.
Idaho Falls, Idaho

MASTER

For the
U.S. Department of Energy
Idaho Operations Office
Under DOE Contract No. DE-AC07-76IDO1570

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ANNUAL REPORT FY 1983

Frank W. Childs

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January 1984

EG&G Idaho, Inc.
Idaho Falls, Idaho 83415

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ABSTRACT

EG&G Idaho, Inc. provides technical assistance and project coordination to DOE for the Geothermal Program Research and Development Announcement (PRDA) Program and Program Opportunity Notice (PON) Programs. Both programs were instituted and funded by the U.S. Department of Energy, Division of Geothermal and Hydropower Technologies (DOE/DGHT) to assist in the development of the direct application of geothermal energy. The projects were then administered by DOE Field Offices in Idaho Falls, Idaho; San Francisco, California; and Las Vegas, Nevada. The PRDA Program consists of a series of studies which investigate the engineering and economic feasibility of geothermal direct heat applications. The PON Program consists of 23 demonstration projects in which project costs are shared between DOE and a private company, municipality, or other organization.

During this reporting period, fiscal year 1983, EG&G Idaho provided program coordination and technical support for eleven demonstration projects and three engineering and economic studies administered by the DOE Idaho Operations Office (DOE-ID).

ACKNOWLEDGMENTS

Division of Geothermal and Hydropower Technologies, Washington D.C., program direction was provided by Eric A. Peterson, Jacob Kaminsky and currently by Gwendolyn K. Redding. Project administration was provided by the DOE Idaho Operations Office, Idaho Falls, Idaho, under the direction of Michael K. Tucker, Dr. Michael J. McLatchy, Susan M. Prestwich and currently by R. Eldon Bray.

Although too numerous to mention individually, EG&G Idaho, Inc. also wishes to thank the principal investigators and project teams from each project for their cooperation with EG&G Idaho, Inc. and DOE in the implementation of these projects.

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DIRECT USE GEOTHERMAL PON AND PRDA
PROJECTS UNDER DOE-ID ADMINISTRATION

1. INTRODUCTION

This report presents the status of Geothermal PRDA and PON projects administered by the DOE-ID as of the end of FY-1983. Both programs were instituted to assist the development of the direct application of geothermal energy. The PRDA Program consists of a series of studies designed to investigate the engineering and economic feasibility of geothermal direct applications. The PON Program consists of demonstration projects in which project costs are shared between DOE and a private company, municipality, or other organization. During this reporting period, fiscal year 1983 (October 1, 1982 through September 30, 1983), EG&G Idaho provided program management and technical support for eleven demonstration projects, three engineering and economic studies plus some general institutional support. Each project is summarized below.

Previous semiannual or annual status reports for the PON and PRDA projects are available as References 1 through 7. They cover the period from October 1, 1978 through September 30, 1982.

The general format for the following project descriptions is to review the activities in FY-1983 separately from background information on project scope and previous years activities. All of the DOE-ID PON experimental demonstration projects are described, but, of 20 studies performed, only the three active PRDA feasibility contracts are covered since they were smaller, more specialized studies.

2. PON PROJECT ACTIVITIES

2.1 Douglas High School, Box Elder, South Dakota

This project was terminated in January 1979.

EG&G Idaho attempted to assist the City of Box Elder in drilling a geothermal production well which was started under separate sponsorship. The well would have been used by the PON project to heat a portion of the Douglas High School with 50°C (120°F) water, but it was unsuccessful due to equipment lost and stuck downhole. The project considered drilling its own well, but the Douglas School Board declined to do so, and the PON project was terminated by mutual agreement. A brief final report was issued in March 1979, Reference 8.

2.2 Ore-Ida Foods, Inc., Ontario, Oregon

This project was concluded in FY-1982.

The objective of the Ore-Ida Foods project was to provide 97,200 MWh/yr (33.2×10^{10} Btu/yr) of geothermal energy for potato processing, space heating and potable water heating. About 50 L/s (800 gpm) of 160°C (320°F) fluid was required to meet this objective. It was estimated that two geothermal production wells would be needed.

In FY-1980, 3064 m (10,054 ft) deep well was drilled, but it produced only 0.82 L/s (13 gpm) of 182°C (360°F) fluid. The drilling cost was only about 8% more than budgeted, but that was enough to use up nearly all of DOE's contribution to the project which was concentrated in drilling the high-risk first well. Ore-Ida declined to continue the project on its own funds since drilling the first well did not reduce the development risk.

The state of Oregon requires that deep wells be plugged when they are abandoned. Ore-Ida agreed to accept well ownership and liability for eventually plugging the well if DOE would provide the funds for the plugging operation. In FY-1981, tests proved that a low-cost plugging

operation was feasible. A price estimate was obtained for plugging the well by pumping cement into the well through the wellhead (no workover rig required).

In FY-1982, Ore-Ida Foods accepted ownership of the well and retained funds for eventually plugging the well. The project was closed out following publication of the final report in July 1982, Reference 9.

2.3 Monroe, Utah

2.3.1 FY-1983

The final report was accepted and the project was concluded in FY-1983. EG&G Idaho, Inc. conducted three reviews of drafts for the final report which were submitted by Terra Tek, Inc. The originals for the final report were received by EG&G Idaho on April 12, 1983, and were sent to DOE-ID with a recommendation of acceptance for publication, Reference 10.

2.3.2 Background

The objective of the Monroe, Utah PON project was to install a core district heating system that could later be expanded to include the major areas of Monroe.

Initial work resulted in a 457 m (1500 ft) deep production well which produced 75°C (167°F) water at 38 L/s (600 gpm), but this was only 43% of its expected capability. In addition, at the preliminary design stage, a 100% project cost overrun and inadequate operating revenues were predicted. DOE suspended the planned project activity and requested that the city find an economic alternative use for the resource.

In FY-1982, publication of the final report was requested since the city had not been able to suitably restructure the project after about a year and a half. Terra Tek, Inc., had nearly completed the draft final report at the end of the fiscal year.

2.4 Haakon School District, Philip, South Dakota

2.4.1 FY-1983

The geothermal heating system operated for the 1982-83 heating season from August 16, 1982 to May 23, 1983. It was operated for showers for basketball players during July 18-22. The 1983-84 heating season was started on August 17, 1983 for football players showers. The project is complete except for the final report.

EG&G Idaho, Inc., personnel inspected and photographed the project on March 22 and 23. Data was gathered for the engineering report and a technical paper. A change in the setting of one valve was suggested which provided greater flow through a heat exchanger and more efficient operation.

A partial rough draft, about 40% complete, of the final report was received from Hengel, Latimer Associates by EG&G Idaho on January 25, 1983. Comments were issued to DOE-ID and the project within a month. In May 1983, Ray Hengel of Hengel, Latimer Associates, Rapid City, South Dakota offered to complete the final report on "down time" in return for a reduced cost to the project. The School District accepted the offer. Completion was expected in about two months, but the draft final had not been received by the end of the fiscal year (four months later).

The old Junior High School building was remodeled outside of the PON project. On September 1, the building was opened with the geothermal space heat and domestic hot water heating for its four elementary classrooms. The school district plans to continue to expand the use of the geothermal system originally built under the PON project.

2.4.2 Background

The initial objective of the project was to provide space heating to a five building school complex. The well which was drilled produced a peak artesian flow of 18.93 L/s (300 gpm) at a temperature of 69.4°C (157°F). The discharge temperature from the complex was determined to be high enough

to allow cascaded use. The project was expanded to transport the geothermal fluid to eight business buildings on the discharge line route plus heating domestic hot water at the school complex.

The radioactivity level of the geothermal fluid was too high for direct surface discharge. The Environmental Protection Agency required that the Ra-226 levels in the well water be reduced to 10 picocuries/liter, prior to discharge to the Bad River. This was accomplished by the injection of a barium chloride solution which caused the Ra-226 to precipitate out in a settling pond. The school system came on-line early in the 1980-81 heating season, and system monitoring was started.

In FY-1982, the eight businesses in the business district were added, system monitoring was completed and several modifications were made to the Ra-226 removal system to reduce maintenance. After these modifications, an open-baffled trough was installed and the injection port for the barium chloride solution was moved to the end of the pipe just upstream of the open-baffled trough. This configuration minimized adherence of the precipitate to the system hardware and still resulted in adequate precipitation of the Ra-226 from the fluid. The final report was in preparation at the end of FY-1982.

2.5 St. Mary's Hospital, Pierre, South Dakota

2.5.1 FY-1983

The geothermal space and hot water heating system has been operating normally this year since the replacement of corroded pipe in the control building. The geothermal system provided space heating to the old building by running the geothermal fluid through the existing air conditioning coils in each room's unit heater. In the spring, water from the chiller is again used for air conditioning each room while that portion of the geothermal system is disconnected.

EG&G Idaho personnel inspected and photographed the facility on March 21 and 22, 1983. An incomplete draft of the final report was received by EG&G Idaho. Its review was postponed since the project was extended to include monitoring of the 1983 through 1984 heating season. Data from previous heating seasons were incomplete or non-representative due to unfinished construction, shutdowns, and abnormally warm weather.

2.5.2 Background

This project demonstrates the feasibility of using very low-temperature water from the Madison Aquifer for a physically-localized space and domestic hot water heating load.

During prior fiscal years, a well was drilled which had a maximum artesian flow rate of 23.7 L/s (375 gpm) with a temperature of 42°C (108°F). Based on the 42°C (108°F) resource, the heating system was constructed and began operation in the fall of 1980.

In addition to providing heat to the 7432 m² (80,000 ft²) existing building, the geothermal system, with a heat pump, also provides heat to a new 6503 m² (70,000 ft²) hospital building. The geothermal system provides all space heating down to -12.2°C (10°F) and domestic hot water and boiler water preheat up to 37.8°C (100°F).

In September 1981, a pinhole leak was found in a 0.91 m (3 ft) long piece of 15.24 cm (6 in.) diameter black iron pipe which was installed between the wellhead and the pressure-reducing valve. The horizontal pipe was replaced and was found to have severe internal corrosion.

Early in FY-1982, about 37 m (120 ft) of 15.24 cm (6 in.) diameter black iron pipe, downstream of the wellhead pressure-reducing valve, corroded through with two pinhole leaks after about a year of service. As a precautionary measure, the geothermal system was shutdown in December 1981. The hospital's old conventional heating system was used from December 1981 to April 1982 until the black iron pipe was replaced with fiberglass reinforced plastic pipe. The hospital, the engineering

firm, and the construction contractor shared the replacement cost since the design called for PVC plastic pipe which would not have corroded. Given the pinhole leak warnings, it was estimated that the down time for pipe replacement could have been held to 1-2 weeks if the replacement pipe had been available.

2.6 Diamond Ring Ranch, Haakon County, South Dakota

2.6.1 FY-1983

The geothermal grain drying, and space and hot water heating system at the Diamond Ring Ranch was re-started in the fall of 1982, but was shutdown when the ranch became unoccupied. The ranch had been put up for sale and was only worked during the day by personnel living off of the ranch. EG&G Idaho personnel inspected and photographed the facility on March 22.

EG&G Idaho received draft copies of the final report from the South Dakota School of Mines and Technology in April and September of 1983. Both reviews were completed within two weeks and marked up copies sent to the project and DOE-ID. Completion of the report is expected early in FY-1984.

2.6.2 Background

During previous fiscal years, a system was designed and installed for grain drying, and for space and domestic water heating on the Diamond Ring Ranch near Midland, South Dakota. It uses geothermal water from an existing artesian well which flows at 10.73 L/s (170 gpm) and 66.7°C (152°F). After flowing through the central heat exchanger, the geothermal fluid is used to water stock and is then discharged into a reservoir system used for both geothermal fluid and surface water runoff catchment.

The system provided heat, as designed, during the 1980-81 heating season. Some freezing occurred in the recirculating loops during power outages. This caused some tubing leaks in a mobile home heat exchanger which were repaired during the summer of 1981.

In the fall of 1981, the recirculating loops, which previously contained fresh water, were charged with a total of 2460 L (650 gal) of antifreeze because of the problem of freezing during electrical outages in the remote area. Btu meters were cleaned and strainers were installed. During the 1981-82 heating season, only the lower recirculating loop was operated, because the two mobile homes on the upper loop were vacant. This was due to limited ranch operation during an ownership change. Preparation of the final report had been started at the end of FY-1982.

2.7 Elko Heat Company, Elko, Nevada

2.7.1 FY-1983

Owyhee Construction Company started construction of the geothermal system on October 4, 1982. The distribution system was completed, and the Vogue Laundry began using softened geothermal water for washing and rinsing on November 24. Space and domestic water heating began at the Henderson Bank Building on December 10. Partial space heating of the Vogue Laundry was added in December. The Stockman's Motor Hotel and Casino switched to geothermal domestic water heating and very limited space heating on February 3, 1983. The Stockman's retrofit was completed on March 18 to complete the switch to geothermal space heating.

The geothermal system operated on artesian flow for the rest of the fiscal year except for short shutdowns for fixing leaks and repairing valves. Two or three threaded steel couplings leaked and were replaced with welded or gasket-sealed couplings.

EG&G Idaho provided specialized radiological analyses of geothermal water samples for the project after the state indicated a concern for water quality. The water was within the EPA primary drinking water for gross alpha and gross beta which avoided a potential surface disposal problem.

The project filed for a Geothermal Operating Permit on August 3, 1983. The Nevada Public Service Commission inspected the project on August 11 and granted the permit on September 19. The quick response was the result of previous coordination efforts.

The project started growing outside of the PON scope. On September 13, the Elko City Council approved an agreement to heat their sewage treatment plant from the geothermal system. Pavement cutting started on September 18 for pipeline installation to the First Interstate Bank Building.

2.7.2 Background

The Elko Geothermal Project uses hydrothermal fluids for space heating and for process heat and water in a commercial laundry, for space and domestic water heating in a motor hotel/casino and for space heating in a bank building.

In prior fiscal years, the project went through an extensive resource assessment followed by site selection, drilling and testing of the production well, EHC GP-1. The geothermal production well was drilled to 260 m (825 ft) and 24-hour artesian and pump flow tests performed. The pump test was used to predict a 5-year continuous-flow drawdown of 42.1 m (138 ft) at 49.53 L/s (785 gpm). The water temperature was 82.2°C (180°F).

In FY-1982, a longer artesian flow test was conducted. During the test, the temperature of the geothermal fluid began to decline. A spinner log of the well was run by EG&G Idaho. It confirmed communication between the geothermal resource and a shallow, cold aquifer through a leak where the well casing changed diameter. The logging confirmed another problem. The open hole was bridged at the 168 m (550 ft) level.

A workover rig was brought in and the well was repaired in June 1982. The repair consisted of cleaning out and deepening the hole to 263 m (862 ft), cementing the casing transition section overlap, and running a 16.82 cm (6 5/8 in.) diameter liner from 74 m (242 ft) to 250 m (820 ft).

The final design was completed in April, and the construction contract was awarded in September. The award of the construction contract was delayed due to the Stockman Hotel owner's concern over reduced investment rate-of-return caused by increased interest rates, higher than expected retrofit cost, and the well repair cost. Additional economic analyses by EG&G Idaho convinced the hotel owner and his accountant that the project would still have an attractive rate of return. The owner of the hotel, who is also the Elko Heat Company's largest stockholder, then agreed to proceed with the project.

2.8 Warm Springs State Hospital, Montana

2.8.1 FY-1983

Construction of the domestic water heating system at the Warm Springs State Hospital was nearly complete at the start of the fiscal year. Completion was delayed by a plumbers' strike in November 1982. Operation of the system was started on January 11, 1983. Final hookup of instrumentation followed by January 14. The system was dedicated on February 18 with about 100 people attending and Governor Ted Schwinder the keynote speaker.

After 15 days of pumped flow at 3.79 L/s (60 gpm) (end of January), the water level in the well stabilized at about 243 m (800 ft) depth with the pump set at 300 m (987 ft). The 30 HP submersible Reda pump in the geothermal well failed on all three electrical legs on March 5. The artesian flow is estimated to be about 28 to 45% of the pumped flow.

The state and MultiTech, Inc., are in dispute on the date the state accepted the geothermal system. MultiTech claims the transfer of responsibility was on February 13, 1983 after a month of training state personnel. The state believes the date is not until April 22 when the operating manuals, component specifications and system drawings were received. The loser receives responsibility for replacement of the failed pump because its warranty has expired. The pump has been in the well for two years since being installed for a well production test.

EG&G Idaho reviewed two drafts of the final report in May and July. The originals for the final report were received and accepted on August 15. Per agreement with DOE-ID, EG&G Idaho is holding the report. Hopefully, operational data with pumped flow can be added to the report prior to its publication.

2.8.2 Background

The objective of this project was to develop the geothermal resource at Warm Springs (on I-15 about 48.3 km (30 m) west of Butte, Montana) to provide both domestic water heating and space heating at the Warm Springs State Hospital. Water from the production well would be pumped through two plate-type heat exchangers and discharged into a waterfowl wetlands disposal area.

In previous fiscal years, flow tests showed that the well would produce 5.68 to 6.31 L/s (90 to 100 gpm). This quantity was inadequate for both space and domestic water heating loads. Therefore, it was decided to design the system to use the 71.1°C (160°F) resource to heat 4.73 L/s (75 gpm) of domestic water from 12.8 to 60.0°C (55 to 140°F). The design was reviewed twice by EG&G Idaho and DOE-ID, and comments were returned to the prime contractor in August and September 1981.

At the start of FY-1982, in October 1981, the project was rescheduled and rebudgeted for the domestic water heating only. In January 1982, EG&G Idaho and DOE-ID made the final design review and again issued comments. The comments were not resolved until April 2, when DOE-ID approved the design and the invitation for bid for construction of the domestic hot water heating system. A construction contract was awarded on June 28 and construction began on September 1. By September 30, 1982 all underground and well head piping had been installed.

2.9 Pagosa Springs, Colorado

2.9.1 FY-1983

The district heating system at Pagosa Springs, Colorado continued using temporary production permits for flow testing Well PS-5 and supplying heat to initial users. These winter "tests" will be used to obtain data to support a permanent production permit from the State of Colorado. EG&G Idaho helped coordinate the application for the 1982-83 heating season after the initial application was rejected. EG&G Idaho set up the conference call which obtained verbal approval for the 1982-83 season's flow tests from the Colorado Oil and Gas Commission on November 16. The duration of the temporary permit was November 15, 1982 to May 15, 1983. Warm up of the system started November 17. Eventually the permit was extended to June 10 due to cool weather.

The first user was Empire Savings and Loan starting November 24, 1982. The Town Hall was added December 6, the high school started early in January 1983, and Superior Automotive began heating on February 4.

Significant coordination was provided to the town's new Principal Investigator by Coury & Associates, Roseberry Plumbing and EG&G Idaho to keep the project organized and to continue progress. EG&G Idaho helped the project revise its budget in the summer of 1983, helped remove errors from invoices submitted to DOE-ID and determined that the town needed to install the Methodist Church pipeline themselves. They could not afford to hire a contractor.

By September 1983, the Methodist Church pipeline was nearly complete and all but one signature had been obtained from existing well owners for the 1983-84 season temporary permit.

2.9.2 Background

The geothermal resource in Pagosa Springs has been in limited use since the early 1900's. Nearly 30 small, historical wells had been drilled for individual heating and recreational purposes prior to starting this project. The objective of this project was to establish a geothermal district heating system from which many of the town's public and private buildings would be heated. The consolidated system would be designed to use the resource more efficiently than the old individual systems which were always run at maximum flow with no controls.

In previous fiscal years, three wells were drilled by the project. Two were good geothermal production wells, PS-3 and PS-5. In the summer of 1980, the two wells were individually and simultaneously artesian flow tested. In the simultaneous test, well PS-3 produced 12.6 L/s (200 gpm) and PS-5 produced 44.2 L/s (700 gpm) for seven days. It was decided to use well PS-5 initially since its fluid temperature was 65°C (149°F) versus PS-3's 55°C (131°F).

In the initial flow tests of the two production wells, the reservoir capacity appeared adequate for a district heating system with a peak flow of 56.78 L/s (900 gpm). It was estimated that this was equivalent to a continuous flow rate of about 25.2 L/s (400 gpm) during a heating season. The distribution system was designed to handle growth to twice the needed capacity. It was anticipated that, as the historical wells and user-systems corroded and were shut down, the historical well owners would join the project's system. Gradually the wasteful full-flow systems would be replaced by more efficient, load-controlled user-systems which would allow more people to be served from the same resource flow.

The district heating system was dedicated on November 21, 1981. Later, during checkout tests, two 20.32-cm (8-in.) diameter asbestos concrete pipes broke. They were found to have been improperly bedded during installation and were replaced by the contractor. Coury & Associates, the system designers, received the 1981 Grand Award for Engineering Excellence from the Consulting Engineers Council of Colorado.

The completed distribution system did not operate during the 1981-82 heating season because the State of Colorado would not issue the production permit for the system's wells unless test data were submitted that showed there would be no interference with existing wells.

Attempts to secure a production permit from the state were complicated by a new permitting procedure involving two state agencies, personnel changes for the Town of Pagosa Springs, and negotiations with about 15 existing-well owners. EG&G Idaho was instrumental in coordinating with the Colorado Department of Water Resources which must assure that existing water rights are protected prior to the Oil and Gas Commission approving the production permit. EG&G was also instrumental in getting the town to appoint a new project principal investigator (Summer 1982) and developing a detailed plan for the completion of the project.

On September 9, 1982, Pagosa Springs received verbal permission from the Colorado Department of Water Resources to do brief flow tests to demonstrate that either interference with neighboring wells was not serious or that well owners would be compensated without calling on the state for water right enforcement. An 85.2-hour artesian flow test of well PS-5, with flow rates up 56.65 L/s (898 gpm), was followed by monitoring recovery for 72 hours. Some interference with neighboring wells was noted, but not enough to preclude moderate operation of the district heating system for initial demonstration purposes. Preparation of an application for a temporary production permit for the 1982-83 heating season was in progress at the end of September 1982.

2.10 Utah State Prison, Draper, Utah

2.10.1 FY-1983

EG&G Idaho received the "working" design for space and water heating the minimum security building from Case, Lowe and Hart, Inc., (CL&H) on November 10, 1982. The design used 31.55 L/s (500 gpm) of 82.2°C (180°F) water from the 305 m (1000 ft) deep well USP/TH-1. EG&G Idaho returned the marked up drawings and telephoned general comments on November 19 and 22

respectively, in preparation for the design review meeting at CL&H's Ogden, Utah office on December 16. The final design, 10 drawings and a 180 page specification, was received by EG&G Idaho on January 27, 1983. The marked up final design was sent back to CL&H on February 17. Then, DOE-ID and EG&G Idaho letters of review comments were issued February 24. The final design review meeting was held at CL&H's Ogden office on March 14. Advertising for construction bids began on March 20 with an April 19, 1983 closing date.

Meanwhile, the project was obtaining required permits. The Utah Bureau of Water Pollution Control notified the project, in November 1982, that system disposal into the Jordan River was approved, and that the US EPA/Denver would be so notified. The project reapplied to EPA/Denver on December 6 to convert their temporary National Pollutant Discharge Elimination System (NPDES) permit for flow testing to a permanent permit. In April 1983, the Utah Division of Natural Resources cut the project's water right application from the requested 2000 gpm to 700 gpm and reserved the right to require injection at a later date. This was documented in their letter of May 27, and was acceptable since the current design only uses 200 gpm. The status of the NPDES permit was unclear. Without any notification, the EPA changed its procedures to add an extra 30-day review period by the affected state (which had already approved the application). This delayed the 30-day advertising period for protesting the permit to a closing date of May 29. Fortunately there were no protests, and the NPDES permit was issued on June 17, 1983.

The construction bids were evaluated on April 19, 1983. The low bidder was Stephen L. Cornwall Co. of Salt Lake City who, fortunately for the project, was willing to extend the term of his bid to July 15. Notice to proceed was given to Cornwall Co. on June 21; four days after receiving the NPDES permit.

The ground breaking ceremony and actual start of construction were both on July 12. The ground breaking was attended by about 40 people and three TV stations with Governor Scott M. Matheson the main speaker. By the

end of the fiscal year, September 30, 1983, several items were installed: most of the disposal pipeline, part of the recirculating pipeline, and most of the concrete tank for settling out calcium carbonate precipitate.

EG&G Idaho received the CY-1982 Annual Report (Reference 11) from the project on August 1, 1983. The report was issued on September 12 after two revision cycles.

EG&G Idaho provided additional technical assistance to the project. Results of the corrosion coupon tests from the summer flow test were issued by EG&G Idaho in October 1982. The 25 HP Johnson Pump which was loaned to the project was received by EG&G Idaho on December 13.

2.10.2 Background

The Utah State Prison is located in Salt Lake County approximately 27 km (17 m) south of Salt Lake City. The objective of the geothermal project is to supply the minimum security section of the prison with space and domestic water heating. The resource surface expression, known as Crystal Hot Springs, is adjacent to the prison. In previous fiscal years, a commercial greenhouse (not a PON project) and the prison project have both drilled geothermal wells into the resource.

In October 1981, CH2M Hill Central, Inc. completed the geothermal water disposal and preliminary design reports. The preliminary design used a shaft-driven pump in the well to avoid dissolution of carbon dioxide gas from geothermal fluid which would cause the precipitation of calcite in the system. Disposal would be by pipeline to the Jordan River if permits could be obtained.

The Utah Division of Facilities Construction and Management (DFCM) took over project management from Utah Energy Office (UEO) and pursued permitting and design tasks. On October 29, 1981, the Utah Water Pollution Control Committee approved surface disposal of the geothermal fluid for a flow test scheduled for June 1982. The state disposal recommendation was forwarded to the EPA/Denver which was reviewing the November 1981

application for a NPDES disposal permit for the flow test. In January 1982, supplementary data was provided per EPA's request. The NPDES permit was issued by EPA on March 8.

On April 5, 1982, Case, Lowe and Hart was selected to develop the final design. By August, the heat exchanger and recirculating loop designs were agreed upon. On September 23, the first of the two following design options was selected: (1) allowing natural, carbon dioxide lift to cause artesian flow followed by the removal of the calcite precipitate and (2) the original shaft-driven well pump design which would keep the carbon dioxide in solution until downstream of the flat plate heat exchanger by maintaining a pressure in excess of about 690 kPa (100 psig) on the fluid.

To determine if there was a resource interference problem, Morrison-Knudsen ran a series of pulse tests followed by a long duration test during the summer of 1982. Each test was naturally artesian with the dissolution of carbon dioxide assisting in lifting the fluid from the well. The long term test consisted of three parts: 18.93 L/s (300 gpm) for 20 days, then 37.86 L/s (600 gpm) for 14 days followed by monitored recovery (no flow) for 10 days. The 34-day flow extended from June 17 to July 19. Analysis of the data indicated that the resource is sufficient for the current prison and commercial greenhouse projects and may be sufficient for significant expansion of its use.

2.11 Madison County, Rexburg, Idaho

2.11.1 FY-1983

EG&G Idaho received the second draft of the final report on November 24, 1982. It was reviewed, and marked up copies were given to Energy Services, Inc. and to DOE-ID on December 10. The published report (Reference 12) was delivered to EG&G Idaho on January 21, 1983. The project was concluded because the temperature of the production well was only 21.7°C (71°F).

2.11.2 Background

The objective of the Madison County Geothermal Project was to demonstrate a low-temperature geothermal resource for food processing and district space heating in Rexburg, Idaho.

In previous report periods, well MCG-1 was drilled and deepened to 1202 m (3942 ft), but the water temperature never exceeded 21.7°C (71°F). A 1.9 L/s (30 gpm) downward flow ran from 731 to 853 m (2400 to 2800 ft) where the hole had sluffed in and bridged across after drilling. It was postulated that warm lower zones might be masked by the cold downward flow, particularly since the lower 143 m (470 ft) had never been logged. The hole was cleaned out and a 20 cm (5.5 in.) diameter liner was installed down to 1079 m (3540 ft). However, the casing hanger leaked and the downward flow continued. The first attempt to patch the leak at the casing hanger failed and the seal assembly was removed.

In October 1981, the reworked seal assembly was installed for the second time. A well log showed an obstruction at 701 m (2300 ft). Airlift tests only produced about 8.83 L/s (140 gpm) versus 15.77 L/s (250 gpm) obtained previously. On November 11, a cable tool rig unsuccessfully attempted to push the obstruction to the bottom of the well with a 272 kg (600 lb) hammer. After waiting for a rig and heavier hammer to become economically available, the obstruction was pushed to the bottom of the well on April 5, 1982. The well was logged the next day. The patch assembly had stopped the leakage and the bottom-hole temperatures, at 1202 m (3942 ft), was 22.2°C (72°F). In a 52.5-hour airlift flow test, the flow had increased to 18.93 L/s (300 gpm) and the maximum temperature of the discharged flow was equal to the bottom-hole temperature. A temperature log five months later, on September 3, showed no increase in bottom-hole temperature.

It was decided to end the project due to lack of resource. The draft final report was reviewed by EG&G Idaho and DOE-ID in August 1982, and returned to Energy Services, Inc., for incorporation of the comments.

2.12 Utah Roses, Sandy, Utah

2.12.1 FY-1983

Dr. Richard L. Miller of EG&G Idaho visited the geothermally heated greenhouse on October 15, 1982. He inspected a leaking copper tube on a unit heater. The leak was on the outside of a 180° bend. It appeared to be a faulty fitting because it was scarred, stretched and thinned in the region of the leak.

EG&G Idaho received the draft final report from Energy Services, Inc. (ESI) early in October 1982 and returned the marked up draft on October 22. A second draft was received on February 22, 1983. It was marked up and returned two days later. A proof copy of the final report was received on February 25, marked up and returned to Energy Services, Inc. three days later. EG&G Idaho recommended publication after incorporation of corrections. The published final report (Reference 13) was received on March 16, 1983 to conclude the project.

2.12.2 Background

The Utah Roses greenhouse complex is located in the town of Sandy, which is approximately 17 km (10.6 m) south of Salt Lake City, Utah. The complex consists of 23,500 m² (6 acres) of greenhouses that produce cut roses for the national floral market. In previous fiscal years, the project drilled a production well to a depth of 1525 m (5009 ft). It can produce water at a pumped flow rate of 12.6 L/s (200 gpm) and a temperature of 50.6°C (123°F) with a drawdown each heating season of about 366 m (1200 ft).

The geothermal water is piped to 43 unit heaters located in the greenhouse. The spent geothermal water will then be discharged to the Jordan River via the Aaranall Ditch. Construction was completed and the system began operation November 4, 1981. The system operated successfully through the winter and was shut down for the summer on May 15, 1982. The NPDES permit only allows discharge from September 15 through May 15.

During that winter, the geothermal system provided approximately 34% of the greenhouse heating requirement. The system was restarted on September 15, 1982 and Energy Services, Inc. was working on the draft final report.

2.13 Boise, Idaho

2.13.1 FY-1983

The Boise Warm Springs Water District (BWSWD) portion of the project was completed in FY-1982. The Boise Geothermal (City) system was under construction at the start of FY-1983. The City had previously installed most of the pipeline from the wells to the downtown area, and four wells had been completed by the private drilling partnership.

The Owyhee Construction Company completed the pipeline to the downtown area. Then, Owyhee Construction bid (11/82), started (12/82) and completed (2/83) the disposal system pipeline to the Boise River except for the permanent diffuser. The diffuser was built, but could not be installed because of high river flows.

Meanwhile, the private drilling partnership started three well houses (No. 2, 3, and 4) and associated piping in December 1982. Flushing out of lines and complete system startup began on February 6, 1983, with the system dedication on February 10. The first users were: City Fire Station (3/83), the City Hall (3/83), the Elk's Rehabilitation Hospital (5/83), and Steiner's Laundry (8/83).

Owyhee Construction later bid (4/83), started (7/83), and completed (9/83) the Main Street Extension of the pipeline. An April 1983 bid opening for the controls for the pressure controls system found all the bids were too high so the city bought components and put the control system together itself. It was completed in September 1983.

Initially, the geothermal flow from well No. 4 was artesian. But, when the Steiner Laundry was operating starting in August 1983, the No. 4 well pump had to be operated.

The No. 4 pump, rated at 18.0 L/s (300 gpm), began to vibrate after several months of operation. It was shut down late in February 1983. After repairs, the pump was placed back in service on June 16, 1984. At the same time, the No. 2 pump was set deeper; from 24.4 m (80 ft) to 30.5 m (100 ft). Vibrations again appeared in the No. 4 pump on September 9. This time the vibrations were in the motor bearings. It was shut down and the much larger No. 2 pump temporarily supplied an excess of water to the system.

EG&G Idaho supported the project with reviews of each subsystem design and bid package. The draft Operating and Maintenance Manual was also reviewed.

2.13.2 Background

The geothermal project in Boise, Idaho has two parts: the City of Boise, and the Boise Warm Springs Water District (BWSWD) which has been in operation since its two wells were drilled in the late 1890s. The City of Boise and BWSWD established Boise Geothermal as the single office through which the DOE project would be managed. "Boise Geothermal" should not be confused with "Boise Geothermal, Ltd." which is the private, limited partnership which is developing the city-owned resource for the City of Boise system. The objective of the geothermal project is to develop geothermal district heating systems to serve the largest possible commercial and residential market in the Boise central business district and neighboring residential areas.

In previous fiscal years, four production wells were drilled for the city system by Boise Geothermal, Ltd. They were 268-613 m (880-2010 ft) deep with 68.3-77.8°C (155-172°F) water and a total flow of more than 126 L/s (2000 gpm). Pipeline designs were in progress, and discharge permits for the vicinity of the Veterans' Park and for near the Americanna River bridge were pending. During the same period, the BWSWD had drilled one 183 m (600 ft) deep well which had inadequate flow, designed and bid a replacement distribution pipeline for its two existing wells, and opened the pipeline

bids on September 30, 1981. By the end of FY-1982, all of the BWSWD replacement, distribution pipeline and 70% of the City distribution system were completed.

The Idaho Department of Health and Welfare approved disposal of the spent geothermal fluid near the Americanna River bridge, upstream of the original discharge points. This is nearer the downtown area. As a result, the estimated cost of the disposal pipeline system was reduced. The design of the disposal system was completed and the contract was awarded in November 1982.

Boise Geothermal Ltd. flow tested the no. 2 and 4 wells for the city in April 1982. The test indicated ample capacity to supply a 126 L/s (2000 gpm) peak system. There are enough interested, and committed customers to fully utilize the 126 L/s (2000 gpm) capacity. Pumps were ordered for the most productive wells, (Nos. 2 and 4) and design of the wellhead piping and pumphouses was started.

The project presented a proposal to the State of Idaho to lease or buy the state's Capitol Mall wells. The project would supply the state with water and use the state wells for additional supply and/or disposal capacity. The state has agreed in principle, but no formal agreement has been reached.

The large, old wellhouse which houses the two, side-by-side BWSWD wells is an officially designated National Historic Landmark. The project had the choice of refurbishing the wellhouse where it stands or moving and preserving the wellhouse plus building a new wellhouse. The latter operation would have been much more expensive. BWSWD elected to refurbish and preserve the old National Historical Landmark pumphouse where it stands, rather than attempt to move it. The refurbishment cost was less than the BWSWD's share of costs committed to the project so DOE did not share in the refurbishment cost. As a result, the DOE work with BWSWD was completed in FY-1982. The BWSWD did the refurbishment and preservation of the historical pumphouse on its own.

3. PRDA STUDIES

3.1 Vale Alcohol

3.1.1 Background

The title of this study is: Engineering, Marketing, and Economic Study of a 4.5-Million-Gallon Geothermal Fuel Alcohol Plant for the Vale Geopark Site. Renewable Energy, Inc. (REI), formerly Technology International, Inc., is conducting the feasibility study and generating a preliminary design for a fuel alcohol plant. It was planned to use data from a 457 m (1500 ft) production well in the study.

In FY-1981, four shallow thermal gradient holes and much of the study design and analysis were completed. During FY-1982, in December 1981, the Environmental Report and Second Progress Report were received and reviewed by EG&G Idaho and DOE-ID. With some interruptions, the 448 m (1470 ft) production well EV-1 was drilled from January through April 1982. Before the well could be tested as part of REI's cost share, REI ran into financial problems. No more work was performed on either the well or the study which planned to use the well test data during the remainder of FY-1982.

3.1.2 FY-1983

REI's financial difficulties have continued and very little work has been performed since September 1982. The well was temperature logged in January 1983. The temperature was only 109°C (229°F) at 168 m (550 ft) where the well bore was clogged. Two project review meetings were held at DOE-ID (11/82 and 2/83). Both were attended by Steve Munson, President of REI, but promised schedules have not been met by REI.

EG&G Idaho, on August 31, 1983, received a floppy-disk of the computer program for the economic analysis of alcohol production plants. The program is an adaptation of the commercial Multiplan electronic spread-sheet code, and was produced on an IBM personal computer.

Additional information on the computer analysis was received by EG&G Idaho on September 9. Mr. Munson stated that this was still a preliminary version of the analysis so EG&G Idaho is waiting for the final version; then only one review need be performed.

3.2 Salida Geothermal, Salida, Colorado

3.2.1 Background

The title for this study is: Resource, Engineering, and Economic Study for Direct Heat Applications of Geothermal Energy at the Salida (Colorado) Geothermal Project. Chaffee Geothermal, Ltd., studied the direct heat application of the Poncha Springs-Salida Geothermal Prospect to the industrial process heat requirements of CoZinCo, Inc., a manufacturer of zinc sulfate, and to other prospective energy users in Salida.

A retrofit design for process and space heating at CoZinCo, Inc., was completed. The resource estimate was 101 L/s (1600 gpm) of 121°C (250°F) water from 457 m (1500 ft) deep. Preparation of the draft final report was started just prior to FY-1982.

The study concluded that the project is an attractive financial venture. Depending on the quality of the resource and the discounted cash flow, rates of return for the Producer and Distributor would be 16% to 39% and 13% to 20%, respectively.

In FY-1982, the draft final report for the study was received and reviewed by EG&G Idaho in March 1982. The draft did not include the zinc sulfate process which was being withheld by Chaffee Geothermal's subcontractor Western Energy Planners Limited (WEPL) because it was thought to be patentable. Comments on the draft were returned to Chaffee who completed the final report, except for the zinc sulfate process.

Late in September 1982, WEPL agreed to release the zinc sulfate process to Chaffee so that they could submit the complete report and meet

their obligation under the cooperative agreement. In return DOE-ID agreed to withhold distribution of the report until WEPL has had time to apply for foreign patents.

3.2.2 FY-1983

EG&G Idaho received the proof copy of the final report in October 1982. Minor comments were telephoned to Chaffee Geothermal, Ltd on October 20 and the published copies of the report were received in November to complete the contractors work. The report had not been publicly released as of September 30, 1983.

3.3 San Luis Valley Ethanol

3.3.1 Background

The title of this study is: Commercial Production of Ethanol in the San Luis Valley, Colorado. WESTEC Services and McCulloch Geothermal Corp., investigated the feasibility of using geothermal energy in the San Luis Valley, Colorado, to provide all or part of the total energy requirements of a 75- to 190-million L/yr (20- to 50-million gpy) ethanol production plant. The study was completed and the draft final report was in preparation at the end of FY-1981. The study estimated a geothermal resource of 28 wells supplying 27.1 L/s (430 gpm) per well at 150°C (302°F) from depths of 3050-3660 m (10,000-12,000 ft).

Early in the FY-1982, the draft final report was received, reviewed and comments transmitted back to WESTEC Services. The comments on the report were extensive, would require considerable work to resolve, and WESTEC had already invoiced for the full amount under the cooperative agreement. Agreement on the revisions was reached.

3.3.2 FY-1983

The negotiations on revising the final report were repeated in FY-1983. WESTEC requested fewer changes in January 1983. EG&G Idaho and

DOE-ID reviewed the requested changes. A DOE-ID letter was issued to WESTEC on February 25 which listed required revisions and offered some technical assistance from EG&G Idaho.

EG&G Idaho received draft copies of the report on June 27. After reviewing, a proof copy of the final report was received on August 15. The DOE-ID approval letter was issued on August 25 and the published report was received on September 26, 1983 (Reference 14).

4. OTHER PON SUPPORT

4.1 R&D Information Study

4.1.1 Background

The title of this study is: Research and Development of Information on Geothermal Direct Heat Application Projects. ICF, Inc., is conducting a study of the more mature PON projects to compile, evaluate, and analyze the data for selected issues; identify and, if possible, circumvent barriers to development; and report on the project. Previously, data were gathered on five selected projects, and a report on the economic analysis of the projects was issued.

During the FY-1982, ICF wrote and submitted a Draft Resource Report and a Draft Development and Construction Report which were passed through two review cycles. It was determined that EG&G Idaho would undertake the revisions of these reports as co-authors with ICF. Meanwhile, ICF would work on the Economic Analysis report which is their primary area of expertise.

ICF's Annual Report was received on October 13, 1981. The five economic analyses, which had been reported earlier, had been updated for current economic conditions and two more projects were added. The data was presented as a paper at the 9th Energy Technology Conference and Exposition on February 18, 1982.

4.1.2 FY-1983

ICF completed the initial draft of the Economic Analysis report which is also the final report for the study. As of September 30, 1983, the draft report was in internal review at ICF.

The Resource Assessment and the Development reports were revised by EG&G Idaho and were sent out for initial draft review by EG&G Idaho (internally), ICF and DOE-ID.

4.2 PON Engineering Study

The PON engineering study was started in October 1982 by EG&G Idaho, Inc. and conducted at a low level of effort through July 1983. It was suspended at that time to await more operating experience from the projects.

Tentatively, eleven projects were selected for analysis assuming that adequate information would be available for each project. The projects are:

District Heating

Boise

Elko

Klamath Falls

Pagosa Springs

Susanville

Institutions

Haakon

Klamath YMCA

New Mexico State University

St. Mary's Hospital

T-H-S Hospital

Warm Springs State Hospital

The New Mexico State University (NMSU) is not officially a PON project, but was conducted in a similar manner.

The drawings and specifications which EG&G Idaho did not have on hand for the projects were ordered and received. Drafts were written for the Haakon School and St. Mary's Hospital projects. Partial drafts were written on the NMSU and T-H-S Hospital projects. Schematics were drawn up on five of the projects.

4.3 GRC Annual Meeting

F. W. Childs of EG&G Idaho attended the Geothermal Resources Council (GRC) 1982 Annual Meeting and tour of Imperial Valley geothermal electric power plant in October 1982. Information on an additive to repress calcite precipitation was obtained and passed along to the Utah State Prison project.

Two papers on the PON projects and two photographs were submitted for the 1983 GRC Annual Meeting scheduled for October 1983 in Portland, Oregon. Both papers were accepted. They are on the St. Mary's Hospital project in Pierre, South Dakota and on geothermal well drilling costs. The results of the photographic competition will be announced at the meeting.

4.4 ASHRAE Activities

Through June 1983, Mr. F. W. Childs of EG&G Idaho was Standards Coordinator for ASTM Technical Committee 6.8 Geothermal Energy Utilization. He became Vice-Chairman of the technical committee as of July 1.

Four papers were reviewed by EG&G Idaho during August 1983. They were for a symposium to be held in January 1984. The title of Symposium AT-64-6 is: Geothermal District Heating Modeling and Ground Water Heat Pump Applications.

4.5 ASTM Activities

Mr. Childs, EG&G Idaho, Inc., served as chairman of the Utilization Subcommittee (E45.20) of the ASTM Geothermal Resources and Energy Committee (E45). The committee and its subcommittee met semiannually and are in the process of developing ASTM standards for the geothermal industry. The first standard from the committee was approved by society ballot in May 1983. It is standard E947-83, Sampling Single-Phase Geothermal Liquid or Steam for Purposes of Chemical Analysis, published in Volume 12.02, September 1983.

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