U.S. DEPARTMENT OF ENERGY
OFFICE OF INSPECTOR GENERAL

REPORT ON THE FIVE-MEGAWATT GEOTHERMAL-
POWER PILOT-PLANT PROJECT

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Deputy Inspector General

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TABLE OF CONTENTS

	<u>PAGE</u>
SUMMARY.....	1
FINDINGS.....	8
No. 1: Project Planning.....	8
No. 2: Facility Design.....	12
No. 3: [Deleted]	
No. 4: Facility Contruction Costs.....	16
No. 5: Geothermal Resource.....	18
No. 6: Geothermal Drilling Program.....	19
No. 7: Two Facility Construction Safety Hazards.....	21
No. 8: Health and Safety Program.....	22
No. 9: Project Reporting.....	23
No. 10: Project Management.....	24
No. 11: Project Control.....	26
No. 12: Quality Assurance.....	28

EXHIBIT A - February 25, 1978, letter re Contract EY-77-C-07-1610
Architect - Engineer Services Raft River Thermal Loop
Facility

APPENDICES

Appendix A - March 19, 1980 Comments from the Assistant Secretary for
Resource Applications on our April 24, 1980 draft report.

Appendix B - Comments from the Assistant Secretary for Resource
Applications on our June 19, 1980 revised draft report.

Appendix C - Comments from the Controller on our June 19, 1980 revised
draft report.

Appendix D - Comments from the Acting Deputy Director, Procurement and
Contracts Management on our June 19, 1980 revised draft report.

SUMMARY

This is a report on the Raft River Geothermal Power Pilot Plant Project (Geothermal Plant) which is a five million watt electric (MWe) experimental facility located near Malta, Idaho. Our review took place between July 20 and July 27, 1979. Earlier this year we submitted for comment draft versions of this report. The comments from the Assistant Secretary for Resource Applications, the Controller and the Acting Deputy Director, Procurement and Contracts Management are contained in the appendices of this report.

The Geothermal Plant is part of the Department of Energy's (DOE) overall effort to help commercialize the operation of electric power plants using geothermal energy sources. The plant will utilize energy from a moderate temperature hydrothermal resource, i.e., water^{1/} at 265 - 295 degrees Fahrenheit to heat and vaporize a secondary working fluid, isobutane. Isobutane, a highly volatile fluid, will in turn drive a turbine generator. The total estimated cost for the project is approximately \$38 million. The plant is scheduled for operational startup in October 1980, and regular operations are scheduled for completion in the fall of 1983.

We found numerous reasons to commend management for its achievements on this project. We would first like to highlight some of these successful achievements. The team that is involved in the project is well qualified and professional. Also, management has been successfully delegated to the field according to the Department of Energy's (DOE) policy of decentralization of project

^{1/} The word "water" in this report refers to a geothermal fluid that contains a high amount of floridation, suspended mineral solids, limestone and other corrosive minerals.

management. The Idaho Operations Office and the prime contractor have implemented reasonably effective management systems for cost control, performance, and project scheduling. Furthermore, the construction manager and construction contractor have implemented an effective and efficient quality assurance program.

One of the problems that concerns us is how the initial goal of the plant was conceived and how this concept has changed in the absence of fully adequate management review. The Raft River Project is now considerably different from the project that was initially proposed in the 1975 Conceptual Design Report.^{1/} The project began as a geothermal electric power pilot plant to be operated by a utility with the aim of demonstrating how a utility, working with its usual staff expertise and operating methods, could economically operate a geothermal power plant. The project is one of several projects in the Department's efforts to commercialize the generation of electric power derived from geothermal energy sources. The Geothermal Plant may now become simply an expensive Government-operated experimental facility if an operating agreement is not reached with a utility consortium.

Meanwhile, as the scope of the work has expanded, the objectives have changed, and the entire development has evolved into new directions. We could find no evidence that several of these program and funding changes had been reviewed and approved at higher levels at DOE Headquarters as had been done by ERDA

^{1/} That report was entitled, "Conceptual Design Report, Geothermal Demonstration Power Plant, 10MW, Experimental Binary System." The report was prepared for the U.S. Energy Research and Development Administration (ERDA). ERDA was one of the predecessor organizations of the Department of Energy.

Headquarters for the original objectives. For example, millions of dollars of new features were added to the project including utilization of geothermal energy to heat the facility and its sidewalks. The additions were made without specific concurrence at the Headquarters level. Furthermore, the Idaho Operations Office suspended negotiations with a utility consortium in August 1979 and assigned a Government contractor instead of a utility to operate the plant.

By noting the dates of the work and the dates that plans for the work were approved, we concluded that many of these changes were implemented before the planning documents for the work were approved. For example, the initial project design work started in 1976, but the Project Management Plan that described this work was not approved until November 1978, some thirteen months after the work began.

In her comments, the Assistant Secretary for Resource Applications wrote that authorization for the project's changes was achieved through detailed annual program plans and budgets, a detailed Project Management Plan, an Energy Systems Acquisition Project Plan and a Project Charter. (See Appendix A.) However, it is our belief that budget plans and appropriation approvals, while useful for Congressional review of funding changes, do not permit adequate Departmental review of project changes. In addition, although we find no fault with the Project Management Plan, the Energy Systems Acquisition Project Plan or the Project Charter, we do feel the approval of these plans and the construction for the project did not proceed in the sequence that would have ensured the most effective project review and approval.

We recommend that future geothermal projects be reviewed, agreed upon and documented in the early stages of the project. Any changes that significantly modify the scope of the project should receive the same review and approval as the original objectives.

Another problem with the project concerns the facility design. Apparently as the result of a lack of ordinary skill by the project's design firm, our reviewers estimate that design errors had generated unnecessary costs of \$323,898 while the Idaho Operations Office estimated these costs at \$113,192.

In design projects, if errors occur because of the lack of ordinary skill on the part of the architectural firm, the firm is normally liable for any damages resulting from these errors. In the case of the Raft River Project, the design drawings and specifications required 195 changes. Of these, 77 changes were the result of design errors and omissions. Many of these errors and omissions surfaced during the project's construction stage and caused construction change orders that normally would have been unnecessary. In addition to these changes, the multiplicity of these errors generated an increase in the cost for in-depth design reviews by the construction management firm which was on a cost-type contract with the Government.

In the future we recommend that a specific clause be included in such contracts to define the liability of the design firm. This liability would apply to any damages suffered by the Government because of design errors caused by the design firm's lack of ordinary skill.

Other problems our inspection uncovered involved facility construction costs, the geothermal research for the program, the drilling program to support the plant cost information reporting systems and safety hazards.

We are particularly concerned about instances of unusually high support building costs as noted by our report on the H-Coal Pilot Plant. ^{1/} We recommend that the DOE Office of Construction and Facility Management or Controller establish maximum standard unit costs for standard support buildings to reduce construction costs. If maximum limits are to be exceeded, project offices should submit justification for these requests on an exception basis in order to strengthen controls over construction costs.

We recommend additional research on the region's geology at Raft River to provide knowledge needed to develop the Raft River's geothermal power production potential. In this regard, we are referring to efforts to increase knowledge and understanding of the Raft River geothermal phenomenon and environment. The research should concentrate on locating faults in the earth's surface for supply wells and on locating sand layers or other disposal zones for injection wells. This research should also verify the existence of an adequate geothermal resource, extraction capability before the Department commits extensive funds for equipment acquisition and facility construction.

It is too late to correct the inadequate well drilling program for the Raft River Project that resulted from overly optimistic assumptions about well

^{1/} Report on the Inspection of the H-Coal Pilot Plant Project, Volumes I and II, dated May 31, 1979.

drilling success rates. However, we recommend that future geothermal projects provide adequate drilling scope and funding to meet the basic and contingency needs of the project.

In the safety area we found two hazards, one involving piping and valves, and the other the battery room in the maintenance building. The metal walls in the battery room of the maintenance building created an electrical shock hazard. We are pleased to note that in July 1979, nonconductive material was substituted for the metal walls. The piping and valves hazard is discussed in our findings.

Other safety problems we uncovered included the lack of emergency measures in the event of an isobutane leak, the placement of emergency equipment in an unsecured building, and the lack of training of the Malta Volunteer Fire Department for handling isobutane emergencies. These deficiencies should be corrected as soon as possible.

The lessons to be learned from the problems of the Raft River Plant are important not only for this project but for application to proposed geothermal plants in the future. In particular, we have in mind the 50 megawatt geothermal power plants in Valles Caldera, New Mexico; Heber, California and the East Coast Geothermal Program. The findings and recommendations of our inspection are discussed in the following pages.

The comments from the Assistant Secretary for Resource Applications on our draft reports are attached as Appendices A and B of this report. These comments clarified several of the issues raised and showed that the Office of Resource Applications has undertaken certain corrective actions

since we issued our initial draft report. Also, the comments on our revised draft report that were provided by the Controller and the Acting Deputy Director, Procurement and Contracts Management are attached in the appendices.

FINDINGS

Finding No. 1: Project Planning

The goals and objectives of the five megawatt Raft River Pilot Plant Project were changed significantly as the project evolved. These changes resulted in an expansion of the technical scope of the work and associated increases in project costs. The expanded scope and the inability to get an electrical utility to operate and maintain the plant make it questionable whether the project can still be considered a "pilot plant."

Discussion

The establishment of clear and stable objectives for research and development projects is important in order to identify the results to be achieved and to enhance project coordination and control. On the other hand, the objectives of research and development projects can be expected to change because of inherent uncertainties in these types of projects.

The Assistant Secretary for Resource Applications noted in her comments that the Idaho Operations Office had a detailed Project Management Plan that was used in FY 1978 by ERDA and DOE Energy Systems Acquisition Project Plan and Project Charter that were approved in June 1979. (See Appendix A.) We found these plans to be adequate; but because many of the goals described in the plans had already been accomplished or were in the process of being completed, we do not feel that these plans were effective management tools. We failed to find management plans that were approved before the Project design of the thermal loop was completed. Moreover, in July 1978 a construction contract was awarded before approval of the management plan in November 1978.

A more detailed description of the changes in the plans for Raft River is outlined below:

- In 1975, according to the initial conceptual design, the project was defined as a ten megawatt pilot plant consisting of two, five megawatt modules. It was defined as a pilot plant because it was to demonstrate that a utility, using the standard operating methods, could economically generate and sell electricity derived from a geothermal source.
- In 1976, the project objectives were modified, and a design contract was executed for a 40 megawatt Thermal Loop Test Facility without a turbine generator that would produce electricity. Instead, the facility would simply test the effect of the geothermal water on various test equipment.
- In 1977, the project objectives were expanded to include a turbine generator, a geothermal sidewalk heating experiment, and a geothermal heating and air conditioning system for on-site facilities. At this stage the plant was reduced in size to a single five megawatt electric pilot plant. The inclusion of power production capability increased the project's cost by \$2.5 million, and authorization and appropriations were obtained from Congress for the increased scope and cost. However, the Headquarters office that had approved the overall 1975 concept did not approve the inclusion of the power production capability. The sidewalk and facility heating efforts were not covered in the planning documents and appeared to meet no

real need. The air conditioning for the facility which was to use geothermal energy was later deleted because of excessive costs compared to conventional systems.

- In early 1978, the final design of the thermal loop was completed, and in mid-1978 a construction contract was awarded. In late 1978, a Project Management Plan was approved which provided detailed technical, institutional, cost and schedule objectives.
- In early 1979, a contract was awarded for the design of the turbine portion of the system. In mid-1979, the Energy Systems Acquisition Project Plan and Project Charter were approved. The Project Plan reiterated the project goals and provided a risk assessment, management approach, and procurement strategy for carrying out the plan. The Project Charter identified the responsibilities and authorities of the managers involved in carrying out the project.

The comments from the Controller state that "we [the Controller] are not aware that the goals and objectives of the project have changed as the project evolved." (See Appendix C.) The "difficulties" that the Controller lists such as, (1) having or not having a turbine/generator, and (2) having or not having an operating contract with a utility company, were potentially major changes to the original objectives. As such, these potential changes warranted review and approval by higher headquarters staff for timely control of major schedule and cost impacts.

For example, the correspondence in Attachment A to appendix A clearly indicates that the decision to assign operation of the plant to EG&G was made by the Idaho Operations Office in August 1979 and involvement of DOE Headquarters was obtained later. In accordance with the management principal of decentralization without loss of control by headquarters, we think major changes to the original objectives of the project should be approved in advance by the Headquarters office that approved the original objectives.

In addition to the fluctuating project objectives, we were particularly concerned that no final agreement had been obtained with a utility consortium to operate and maintain the pilot plant upon completion of construction in June 1980. In August 1979, the Idaho Operations Office had suspended negotiations with the utility consortium after being unable to reach a final agreement for nearly two years. After failing to reach an agreement, the Idaho Operations Office assigned a nonutility Government contractor to operate the plant. However, in order for the project to be a "pilot plant," it should demonstrate that a utility can operate the plant and economically sell the generated electricity.

The fact that the Government and its technologically sophisticated contractor can produce electricity from hot water would not aid in the commercialization of geothermal energy resources. It is well known that hot water can be used to generate electricity. We were encouraged to learn that subsequent to our inspection, the Idaho Operations Office had reopened negotiations with the utility consortium; however, as of early June 1980, no agreement had been signed.

Recommendation

We recommend that future geothermal project objectives be developed, reviewed and approved in the early phases of the project's formulation. In addition, changes that expand or contract the scope of the project should receive the same review and approval as the original objectives. We also recommend that the Division of Geothermal Energy state what project features must be maintained in order for a project to remain a pilot or demonstration plant. Written approval should be obtained before such features are eliminated.

Finally, we recommend that a final agreement that would be of mutual benefit to both parties be obtained with the utility consortium as soon as possible.

Finding No. 2: Facility Design

Design errors and omissions by the architect-engineering firm that designed the Raft River Thermal Loop Facility caused unnecessary costs totaling at least \$113,192.

Discussion

When errors occur in the execution of contract documents developed by an architect engineering firm, general business practice is that the firm is liable to the Government for any damages caused by errors resulting from lack of ordinary skill. In the case of the Geothermal Plant, the design drawings and specifications required 195 changes. Of these 195, 77 were

the result of design errors and omissions that raise a question about the skill level of the design contractor.^{1/}

In addition to the 195 design changes, there were 24 construction changes. Of these 24 changes, we feel 17 were caused by earlier design errors. These errors did not become apparent until the construction stage of the project. In our view, these 17 errors unnecessarily cost the Government \$323,898 which was approximately 5 percent of the construction contract cost.

Examples of construction change orders caused by design errors are set forth below:

- (1) low cost items (\$9,330) such as omission of structural concrete from the original design for the maintenance building and tank farm area;
- (2) moderate cost items (\$40,000) such as the inadequate size of the fire pump; and
- (3) high cost items (\$155,000) such as the overdesign of the flare system.
(If the flare had not been corrected, it would have burned \$67,000 worth of propane per year instead of only \$7,000 worth of propane which is the amount necessary for a normal sized flare system.)

1/ Prior to our review, the president of the design firm had communicated to Idaho Operations that in his view the firm "has been unjustly accused of failure to perform." The firm's position on this matter is more fully set forth in Exhibit A.

The Idaho Operations Office felt that only 8 construction change orders worth \$113,192, (or 2 percent of the construction contract cost) were due to design errors and omissions. The magnitude of the design errors also generated increased cost for in-depth design reviews by the construction management firm which was on a cost-type contract with the Government.

We feel that the Government provided more than ample funding to obtain adequate design services. For example, the estimated cost of the design work increased from \$576,233 to \$826,000 (43 percent increase) and this cost plus a \$53,914 fixed fee amounted to 13.2 percent of the \$6,678,000 construction contract price. In our view, an abnormal number of unjustified design errors developed that resulted in unnecessary cost increases for the Government.

We take exception to the comments by Idaho Operations and the Assistant Secretary on our finding on the facility design errors. (See Appendix A.) As we stated earlier, by our calculations at the time of the inspection the errors represented 5 percent of the construction cost rather than 2 percent. We also feel that neither \$323,898 nor \$113,192 constitute insubstantial amounts of unnecessary expenditure. Our concern over this amount of money is heightened by the fact that the sum represented errors made by the architect engineering firm which were absorbed by the Government.

We are also concerned by the response from the Acting Deputy Director, Procurement and Contracts Management to our June 19, 1980 report. The Acting Deputy Director wrote that, "except for gross negligence on the part of the A&E firm's management, which has not been made evident on [sic] the subject project, it is our opinion that provisions establishing A&E liability for damages under a cost

reimbursement type contract are not considered compatible with this type of contract."

Our understanding of current business practice and applicable procurement regulations is that if an architect allows errors or defects to occur because of his negligence or lack of ordinary skill, he is liable to the owner for damages suffered. Moreover, the accountability for performance and liability for damages suffered due to design errors and omissions clearly rests with such architect-engineer firms rather than the Government or construction contractors.^{1/}

Recommendation

The Idaho Operations Office should seek reimbursement of the unnecessary costs caused by design errors by the architect-engineering firm. To ensure that the Department does not have recovery problems with contracts in the future, all future architect-engineering contracts should define the design firm's liability for damages incurred by the Government as a result of design errors due to lack of ordinary skill by the firm. Also, the Government should be reimbursed for any such damages suffered. In addition, the design firm should be represented on the construction change order negotiation team in order to review construction change orders allegedly caused by design errors.

^{1/} See "Procedures Used For Holding Architects And Engineers Responsible For The Quality Of Their Design Work," GAO Report LCD-76-333, July 14, 1977.

Finding No. 3: [Deleted]

Finding No. 4: Facility Construction Costs

Separate support buildings generated unnecessary costs of \$119,000 to \$128,000.

Discussion

There were several separate high priced support buildings that were under construction at the Geothermal Plant at the time of the inspection. The largest facilities were the office and control building with a total cost of \$414,169 (unit cost \$92 per square foot); the maintenance building with a total cost of \$367,579 (unit cost \$85 per square foot); and the cooling water pump house which cost \$211,257 (unit cost \$56 per square foot). All unit costs were taken from contractor's costs.

We estimate that \$119,000 could have been saved by combining the office and control and maintenance buildings. Had the cooling water pump house and the maintenance building been combined we estimate that \$128,000 could have been saved. The savings would have resulted from consolidation and reduction of support space, equipment, exterior walls and utilities and land improvement. Consolidated buildings would have also meant reduced operation and maintenance costs during the project's operational phase.

We feel that initial construction cost would have been reduced had these buildings been combined. Furthermore, we believe plant operations would have been more efficient and maintenance cost would have been reduced using effective combined buildings. Moreover, we think the advantages could have been obtained without detracting from the mission of the project.

Idaho Operations takes a contrary position, but no specific documentation was provided to us to support Idaho's view that the actual facility construction represents the most cost effective approach. (See Appendix B.)

In his comments on our revised draft report, the Controller objects to our recommendation that maximum standard unit costs for standard support buildings be established. (See Appendix C.) However, the "Cost Factors Manual" that the Controller states will be developed by his office would contain the same cost standards we recommend although termed "cost guidance" by the Controller. We still feel that this cost guidance should be provided as maximum allowable limits with mandatory enforcement provisions. We also believe that the reasonableness of our cost standards recommendations is strengthened when considered in conjunction with our recommendation that deviations should be permitted when properly justified.

Recommendation

We recommend that the DOE Office of Construction and Facility Management or Controller establish maximum standard unit costs for standard support buildings.

We recommend that the project offices be required to submit justifications for requests to exceed the maximum limit.

We also recommend that the program and support offices of the Division of Geothermal Energy review future pilot and demonstration plant plans in an effort to combine semi-compatible support functions as a way of reducing the cost of building construction, operation and maintenance.

Finding No. 5: Geothermal Resource

The geological research for the project's drilling program was inadequate in certain specialized areas. All geothermal systems did not receive total system testing before major construction started, and recent test data show that the geothermal fluid may not be hot enough to generate electricity economically during the future operational stage.

Discussion

Extensive geological research had been performed in the Raft River area by the United States Geological Survey and other organizations. It was our conclusion that the overall research on the reservoir engineering was satisfactory, however, additional research was needed on finding the underground faults (cracks) through which the geothermal water flowed. This action would have assisted in locating production wells at the most favorable location in order to maximize the quantity of fluid extracted and to minimize the cost of well drilling and rework. Also, additional geological research would have assisted in locating injection wells at the most favorable locations in order to maximize the quantity of fluid to be disposed of and minimize the cost of well drilling and rework.

The design for the pilot plant called for 2,250 gallons per minute of 290 degrees Fahrenheit low salinity geothermal water at the heat exchanger. Recent test data indicate that the water temperature at the heat exchanger will be in the range of 270 degrees Fahrenheit. Water at this temperature may have a future negative impact on the ability of the plant to generate electricity economically because the plant electrical output will be sensitive to fluid temperatures delivered significantly below 300 degrees Fahrenheit.

Recommendations

We recommend that all planned testing of the supply and injection system and piping material be concluded as quickly as possible. Analyses should be made to determine what effect the colder than designed temperature will have on the capacity of the plant to produce five megawatts of electrical power on an economical basis.

In addition, we recommend that additional research be conducted on the region's geology to provide the knowledge needed to subsequently develop the Raft River's geothermal power production potential and disposal of used geothermal fluid.

Further, geothermal related projects should conduct extensive geological examinations in order to verify at an early stage the existence of an adequate geothermal resource extraction and injection capability before extensive funds are committed for equipment acquisition and facility construction.

Finding No. 6: Geothermal Drilling Program

The drilling program that was planned to support the Five Megawatt Geothermal Plant at Raft River did not include adequate contingency funds to accommodate unforeseen drilling requirements such as rework of existing wells or drilling of additional new wells if rework was unsuccessful.

Discussion

When the Division of Geothermal Energy approved the design for this plant, the Division authorized the drilling of seven geothermal wells. These consisted of three production wells, two injection wells, and two standard reserve wells,

one for production and one for injection. These two wells would be needed when operational wells were shut down for maintenance. The Division estimated that this was the minimum number of wells needed for the project and that the quality of each well in terms of flow rate and water temperature would meet minimum design specifications.

When the actual performance of all production and injection wells did not meet expectations, extensive rework was required on certain wells. Examples follow:

- (1) Well No.3 was drilled with multiple legs and was supposed to produce 50 percent more production than would a single hole; however, total production from the well was less than that from single hole Wells Nos. 1 and 2;
- (2) Well No. 4 did not accept injection of used geothermal fluid nor could it produce an acceptable quantity of geothermal fluid even after extensive rework;
- (3) Well No.5 had one leg sealed in with cement and a second leg even after rework produced geothermal fluid with an unacceptable temperature of 255 to 265 degrees Fahrenheit; and
- (4) Well No. 7 required stimulation in an attempt to increase injection flow.

Due to the marginal nature of many of these wells, the project had to consider drilling new wells to meet minimum project needs. It was ultimately decided that reworking the wells that had already been drilled would be less costly than paying for new wells.

Since inadequate contingency funds were provided within the project budget to meet all drilling contingencies and other unexpected project needs, \$1.25 million of funding were obtained from a separate Department of Energy well stimulation program. We feel that a more comprehensive drilling program could have anticipated a need for adequate drilling contingency funds.

Recommendation

We recommend that for all future geothermal projects, the Division of Geothermal Energy provide adequate drilling scope and funding to meet the basic and contingency needs for the project.

Finding No. 7: Two Facility Construction Safety Hazards

1. The piping and valves did not have the appropriate number of threads on their bolts and shanks at the time of the inspection.

Discussion

We inspected the process area and maintenance building to examine selected quality assurance records, drawings and specifications in order to compare them to actual hardware installation. In the process area we found insufficient threads on bolts, and we noted that shanks on piping and valves

did not extend beyond their related locking nuts. This situation could result in an uncontrolled release of process steam or isobutane which could be a serious safety hazard for the operations staff.

Recommendation

The appropriate number of threads on bolts and shanks on piping and valves should be provided to prevent a possible accident during the project's operational stage. We urge that the piping be inspected before acceptance to ensure that measures described in the Assistant Secretary's comments have in fact been taken.

2. A battery storage room was enclosed with corrugated sheet metal that could cause serious electrical shocks.

Discussion

A battery storage room in the maintenance building was enclosed with corrugated sheet metal at the time of the inspection. If someone were to accidentally touch both the batteries and the metal wall, a serious electrical shock could result.

Recommendation

Following our inspection, we were advised that in July 1979 the sheet metal in the battery room was replaced with an electrically nonconductive material.

Finding No. 8: Health and Safety Program

Improvements were needed in the health and safety program involving isobutane leaks and the emergency equipment building.

Discussion

The site emergency procedures did not discuss actions to be taken in the event of an isobutane leak. The Malta Volunteer Fire Department was being relied upon as a backup in case of emergencies, but there were no plans for training the Department's personnel to handle isobutane emergencies.

The emergency equipment building door was secured with a removable wooden peg rather than being secured with a tamperproof seal in accordance with specified site procedures. An examination of the building showed that it contained equipment that plant personnel could use for both emergencies and everyday use. Because the building was not properly secured, there was a clear possibility that the emergency equipment might be used in nonemergency situations.

Recommendation

We recommend that these deficiencies be corrected as soon as possible. In her comments, the Assistant Secretary for Resource Applications informed us that since our inspection the emergency equipment building door had been provided with a locked padlock and with an accessible key enclosed in a nearby breakable glass enclosure.

Finding No. 9: Project Reporting

Excessive reporting of administrative and cost information is consuming a significant number of critical staff hours that could more profitably be spent on the technical and management aspects of the project.

Discussion

The project office was required to prepare and submit eleven monthly reports and five special periodic reports in addition to those required by the Uniform Contractor Reporting System. These reports cover a wide spectrum of information from cost and procurement data to technical status and plans.

Some of these reports were an outgrowth of the Uniform Contractor Reporting System and are not specifically required by it. Other reports, however, are carry-overs from previous requirements such as the Energy Research and Development Administration's Manual Chapter 6101, Headquarters program letters, and Schedule 189s.

The Idaho Operations Office and the prime contractor have fully implemented the Uniform Contractor Reporting System. Timely information on costs, manpower, schedules, and performance is thus available to several levels of management at the Idaho Operations Office and Headquarters.

Recommendation

The Idaho Operations Office should reduce duplicative reports required for this and other projects. Only the minimum number of reports needed to manage and control the project effectively should be required.

Finding No. 10: Project Management

Management of the Raft River Geothermal Plant has been successfully delegated to the field in accordance with the DOE policy of decentralized project management.

Discussion

The Headquarters Division of Geothermal Energy provides overall program guidance and interpretation of DOE and national goals through program letters and financial plans sent to the Idaho Operations Office. In this manner, Headquarters currently reviews and approves major project milestones, goals, costs, and schedules, as well as handling coordination with the other Federal agencies. The Director of Geothermal Energy has appointed a full-time program manager to oversee this project and assure that all programmatic responsibilities are carried out.

The Idaho Operations Office provides overall management and control of specific project activities including such matters as submission of requests and authorizations for project funding, design approval, technical surveillance, auditing, performance evaluation, and technical and administrative reporting. The Idaho Operations Office uses its operations contractor, EG&G Idaho, Inc., to maintain overall technical management and to provide direction to the architect and engineering contractors, and the construction and equipment contractors.

EG&G Idaho, Inc. provides project management functions including tracking of costs versus schedules, and monitoring and reporting progress. Furthermore, EG&G provides variance analyses, system integration, and contractor and subcontractor coordination. EG&G also monitors and initiates corrective actions. In addition, on August 31, 1979, EG&G was assigned by the Idaho Operations Office to operate the plant.

The Idaho Operations Office has assigned a full-time on-site manager. Management and control of the design and construction work were retained at the Idaho Operations Office. The site manager is responsible for day-to-day coordination of Raft River activities. He represents the Government at weekly and monthly contractor meetings. The site manager works with the Raft River Rural Electric Co-op and with state and local officials who might have an interest in the project. The site manager has complete authority and responsibility for environmental control, safety, security, operation and coordination of site related activities.

A Project Charter has been prepared outlining the roles and responsibilities of the various organizations and individuals involved. Though approval of this Charter had been delayed, the policies and assignments in the Charter had been implemented.

Recommendation

None

Finding No. 11: Project Control

The Idaho Operations Office and EG&G Idaho, Inc. have implemented effective systems to try to control the costs, performance, and schedule aspects of the project.

Discussion

The Headquarters Program Manager established firm guidelines regarding management, control, and reporting of project activities. The Idaho Operations Office in turn prepared extensive planning documentation and selected proper management tools for the size of the project.

A five-level work breakdown structure had been developed. Project cost estimates, based on this system, were prepared after conceptual and Title II design efforts for the turbine generator and the thermal loop facility were completed. The accounting system was designed to summarize cost data from the lowest level of the work breakdown structure and to collect, identify, and report actual costs. Cost control monitors, who are also technical managers, compare the budgeted cost of work scheduled with the actual cost of work performed. This data was used by the cost control monitors who worked with the cost account managers and planning and scheduling personnel to determine the earned value of the work performed. Significant cost variances were analyzed and explained by the cost control monitors in variance reports that were issued each month. We consider this system to be reasonably effective.

The development of the work breakdown structure was paralleled by the preparation of network and master baseline schedules. The day-to-day work was controlled by the use of work schedules prepared and maintained by the technical managers.

Change control boards had been established to review and approve proposed changes. The inspection revealed that design changes, contract change orders, and contract modifications had been combined into manageable units.

The overall project cost, performance, and schedule had been well controlled; and the project was within the latest projected costs and schedule at the time of the inspection in late July 1979.

There had been proper delegation of authority and responsibility from the Headquarters Department of Energy to the Idaho Operations Office and within both

organizations. The Idaho Operations Office has applied, to the extent needed, the elements of the Performance Measurement System and the Uniform Contractor Reporting System.

Recommendation

None

Finding No. 12: Quality Assurance

An effective and efficient quality assurance program was being implemented on the Raft River Project.

Discussion

The construction manager EG&G Idaho, Inc., and the construction contractor, Mitchell Construction Company, were contractually required to implement quality assurance programs. A review of their responsibilities, duties and activities indicated that an effective and efficient program was being implemented. There was no evidence of duplication in the area of quality assurance. Moreover, we found definite evidence of complementary and supplementary efforts at each organization. The quality assurance activity for the most part was conducted by EG&G Idaho, Inc. with only a basic inspection effort. Mitchell Construction Company had overseen the quality assurance actions. The organizational responsibilities were acceptable.

Recommendation

None

EXHIBITS

- A - February 25, 1978, letter re Contract
EY-77-C-07-1610 Architect - Engineer
Services Raft River Thermal Loop Facility

ARCHITECTS
ENGINEERS
CONSTRUCTORS

EXHIBIT A

7738/EFS
25 February 1978

FACILITIES SYSTEMS ENGINEERING CORPORATION
8332 OSAGE AVENUE • LOS ANGELES, CA. 90045 • (213) 776-7300

United States Department of Energy
Idaho Operations Office
550 West Second Street
Idaho Falls, Idaho 83401

Attention: Charles Williams, Ph.D
General Manager

Subject: Contract EY-77-C-07-1610
Architect-Engineer Services
Raft River Thermal Loop Facility

Dear Dr. Williams:

I did not continue our direct communications on the subject contract as we had discussed in our telephone conversation of February 15, 1978, because Mr. Wayne Knowles advised me that I should forego direct communication with you. I hope that Mr. Knowles has advised you that I have been even more deeply involved in the work of this contract than I had been previously. I believe, however, that foregoing direct communication with you has not been in the best interest of Facilities Systems Engineering Corporation or the Department of Energy.

Briefly, the documentable evidence of the course of events of the Architect-Engineer Services on this project shows substantially and clearly that Facilities Systems Engineering Corporation has been unjustly and inaccurately accused of a failure to perform. At this particular period, I don't think that it is appropriate for me to consume your time or my energy to pursue these matters in depth; rather, it is appropriate that all of the resources of Facilities Systems Engineering Corporation be directed toward the rapid completion of the contract work.

I do, however, respectfully request one hour of your time at some future date convenient to you. At that time, I will present to you a documented history of the critical issues on which we have been accused of wrong-doing. I will show with supportable evidence that Facilities Systems Engineering Corporation has performed and served the best interest of the Government at all times, without exception, and beyond either legal or moral obligations of the subject contract.

RECEIVED

FEB 27 1978

GEOHERMAL ENERGY
BRANCH

More specifically, Facilities Systems Engineering Corporation will show the following:

1. Project Schedule

That late determinations of material selections for heat exchangers, unnecessarily long procurement periods, failure to deliver shop drawings, unreasonable long periods involved in reviews, and failure to make critical decisions are the principal cause of delay.

That our current overexpenditure is substantially less on a proportional basis than the time period involved in schedule slippage.

That Facilities Systems Engineering Corporation has made substantial efforts to recover time lost for reasons beyond their control.

2. Quality

That your current understanding of the quality of the work supplied by Facilities Systems Engineering Corporation is not supported by the facts. Facilities Systems Engineering Corporation is prepared to show that comments made on our work directed their attention toward quantity rather than quality. Our analysis of the comments that we have processed indicates the following distribution:

- a. Subjective, personal choice, speculative, incorrect or indicative of a lack of understanding of the work by the individual assigned to check the work: 69%.
- b. Changes in instructions previously furnished: 7%.
- c. Errors of omission or commission by FSEC: 24%.

With regards to the errors of omission or commission by FSEC, we will show that the impact on construction costs (Change Orders) and/or scheduling of the contractor's operations would have been the magnitude of approximately 10% of the national average for similar work.

United States Department of Energy
Attention: Charles Williams, Ph.D

25 February 1978
7738 Page Three

I want you to know that FSEC highly regards the assignments from DOE, and that the company has an excellent reputation for controlling costs and maintaining schedules. We value this reputation, and we intend to continue to maintain it. The information furnished to you on our performance is incorrect and has seriously jeopardized our relationships with DOE. We believe that we are entitled to "a day in court".

Very truly yours,

Edward F. Slattery
BY *f MT*

Edward F. Slattery
President
Facilities Systems Engineering
Corporation

EFS:bb

cc: Mr. Wayne Knowles

APPENDICES

Appendix A - March 19, 1980 Comments from the Assistant Secretary for Resource Applications on our April 24, 1980 draft report.

Appendix B - Comments from the Assistant Secretary for Resource Applications on our June 19, 1980 report.

Appendix C - Comments from the Controller on our June 19, 1980 report.

Appendix D - Comments from the Acting Deputy Director Procurement and Contracts Management on our June 19, 1980 report.

Department of Energy
Washington, D.C. 20461

MAR 19 1980

MEMORANDUM FOR: Deputy Inspector General

FROM: Assistant Secretary for Resource Applications

SUBJECT: Draft Report on the Five Megawatt Geothermal
Power Pilot Plant Project

In response to your request, we have reviewed the subject draft report and the positive findings contained in the report are appreciated. You requested comments on the accuracy of the draft report and corrective actions taken or planned in response to your recommendations. The attached document summarizes our comments on the draft report for your consideration. It also provides specific comments on each of the findings included in the report, including the corrective actions that have been undertaken.

We understand that the review of the project was accomplished in a very short time. Due to the time constraint, certain documents or discussions may have given the reviewers the wrong impressions. Therefore, we have provided additional information on the history of the project that should be considered in your final report.

A handwritten signature in cursive script, appearing to read "Ruth M. Davis", is positioned above the printed name.

Ruth M. Davis

Attachment: Comments on Draft Report on the
5 MWe Raft River Pilot Plant Project

Prepared by: RA/DGE:MScheve:633-8110:3-12-80

Summary Comments on the Office of Inspector General
Draft Report Inspection Findings
on the 5 MWe Raft River Pilot Plant Project

The initial goal of the Raft River Project was well defined by the Cooperative Research and Development Agreement signed between the United States Energy Research and Development Administration (ERDA) and the Raft River Geothermal Development Cooperative, Inc., on December 17, 1975. The goal and objectives have not changed since their initial formulation nor has the basic project plan.

During FY 1976, it was planned to test two wells, RRGE-1 and RRGE-2, under the Geothermal Resource Evaluation Program and, if initial tests were successful, to drill an additional production well, RRGE-3, and an injection well, RRGE-4. During FY 1976, a conceptual design of a 10 MW electric equivalent thermal experimental loop design was finalized. Initial well tests of RRGE-1 and 2 indicated that the resource had the potential to supply fluid of approximately 290°F and possibly 600 gpm per well using downwell pumps. Wells RRGE-3 and RRGE-4 were also successfully drilled during FY 1976 and FY 1977.

The conceptual design of the loop indicated that over 4500 gpm of 290°F geothermal fluid would be required for a 10 MW electric equivalent experimental loop (80 MW thermal). This would require eight production wells and four injection wells plus spares, substantially increasing the overall cost of the facility and well field. It was decided by ERDA-Headquarters management to reduce the requirements by 50 percent and design a 5 MW electrical equivalent thermal experimental loop. It was determined that the primary objective of the project "to determine the economic, environmental and technical feasibility of the production of electric power from a moderate temperature (approximately 300°F) hydrothermal resource" could still be obtained with the smaller test facility.

DOE's budget submittal for FY 1977 to Congress (Transition Quarter 76 plus FY 1977) proposed a 40 MWt (5 MWe equivalent) Raft River Thermal Loop Facility Project. Funds were appropriated in FY 1977 by Congress to initiate the Project. The conceptual design for the facility was completed in August 1976 and preliminary design was initiated in October 1976. The Raft River Rural Electric Cooperative proposed to pay under the initial agreement for adding a turbine/generator and converting in the future the thermal loop facility to a 5 MWe pilot plant to produce power for their local grid. In FY 1977, the Cooperative found they could not pay for the modifications and addition of the turbine/generator. However, the Cooperative and other regional utilities expressed strong desire for the addition of the turbine/generator.

Because of continued interest from the utilities, it was decided that the plant should be operated as a commercial power plant after the DOE test program was completed. With this objective, ERDA submitted an FY 1978 budget request to Congress for the addition of the turbine/generator to convert the thermal loop facility to a 5 MWe electric power pilot plant. The FY 1978 appropriation permitted conversion to a pilot plant.

The geothermal effort at Raft River initially had problems with effective project management. This was principally due to frequent changes in Headquarters, Operations Office and Prime Contractor personnel, caused by the AEC to ERDA transition in FY 1976, Idaho National Engineering Laboratory (INEL) prime contractor replacement in FY 1977, ERDA to DOE transition in FY 1978. However, during these periods, authorization and control of the project by DOE Headquarters management was effectively accomplished by yearly approval of detail annual program plans and budgets (i.e., Schedule 189) for the project and other Raft River geothermal efforts. These were supplemented by the preparation and approval of detail Schedule 47's for the annual budget submittals to Congress.

During FY 1977, the Idaho Operations Office was directed to initiate the new ERDA Uniform Contractor Reporting System and to prepare a detail Project Management Plan for the project. This management plan was prepared per ERDA Appendix 6101 format and used during FY 1978. The DOE Under Secretary on May 31, 1978, required that Energy System Acquisition Project Plans (ESAPP), Project Charters and Project Management Plans be developed for all Major System Acquisitions (development and construction projects over \$50 million, reference DOE Order 4240.1) following prescribed formats. Smaller projects were not required at that time to develop ESAPP or Project Charters but it was recommended that detail Management Plans be used. The Project Management Plans for the 5 MWe Raft River Pilot Plant received final approval in November 1978. On January 22, 1979, some smaller construction projects, such as the Raft River Pilot Plant, were required to develop an ESAPP and Project Charter. These were prepared and finally approved by the Assistant Secretary for Energy Technology in June 1979.

An initial objective of the project was to have direct participation by utilities and private industries in the operation and evaluation of the plant. This objective is still being pursued (see Attachment A). Initially, the Raft River Rural Electric Cooperative, Inc., was interested, but their financial situation prevented them from undertaking the operation alone. They and several other utilities formed the Geothermal Power Development Group (GPDG) to accomplish this objective. An interim agreement was signed between DOE and GPDG, which is still in effect, to accomplish the initial effort. However, a final agreement could not be satisfactorily negotiated. There were two main problems: (1) GPDG or one of the lead utilities did not want to assume contractual responsibility for plant operations, and (2) GPDG wanted first right-of-refusal to acquire the plant and associated well field equipment owned by DOE and the land on which the equipment is located and the geothermal resource required for long-term plant operation. The land and the resource are administered by the Bureau of Land Management (BLM).

To keep the project on schedule, EG&G was assigned responsibility for operation of the plant and the preparation of the operation and maintenance manuals. EG&G was requested to involve the utilities to the maximum practical extent. They were specifically requested to involve the GPDG. In the meantime, the two major problems with GPDG are still being addressed by DOE and the Department of the Interior (See Attachment A).

The Division of Geothermal Energy has the responsibility of developing applications for geothermal energy. At Raft River, there are electric and nonelectric programs aimed at developing and demonstrating potential applications. These projects consist of evaluating advanced systems for electric energy production, space heating and air conditioning, food and chemical processing and drying, aquaculture and agriculture applications. It is felt these techniques should be initially demonstrated, where possible, at Government facilities.

Under DOE Conservation orders and recommendations, all DOE-funded facilities are required to evaluate renewable energy resources as replacements to the use of nonrenewable resources, such as oil or gas. The Raft River facilities were evaluated and geothermal heating was found to be a viable alternative to the use of fossil energy. Air conditioning for the facility using geothermal energy was not found to be economically feasible based on available commercial equipment for low- to moderate-temperature geothermal resources.

The skill of the architectural firm and the design review contractor concerning the facility design has been questioned based on design errors which have generated additional costs totaling \$113,192. Although changes due to design errors and omissions should be unnecessary, it is felt that a \$113,192 addition on a \$6,678,000 construction is nominal, less than 2 percent. Total change orders were less than 4 percent. Contingencies planned on construction projects normally range from 15 percent to 20 percent. On a first-of-a-kind binary geothermal power plant without prior experience and at a remote site, this performance on the part of the contractors is very good.

The 5-ton built-in crane for the cooling water pumphouse costing approximately \$55,000 is considered necessary. This crane is used to extract the cooling pumps from their wells. This is a direct overhead lift of over 6 feet under close tolerance. To accomplish this with a mobile crane from outside the building would require a removable roof, sealed to exclude isobutane vapors, on the building and a crane with a large boom extension, which makes it difficult to hold close tolerance during lifting or replacing. The built-in crane is also used for maintaining the other equipment in the building, which is extensive. The water treatment tanks and equipment occupy most of the area. The built-in crane allows any piece of equipment to be moved to the door of the building where a fork lift can transport the item to the Maintenance Building. On-site capability to transport equipment consists of a 6-ton fork lift, two 12-ton fork lifts, and an 8-12 ton Gallion crane. Additional capability can be obtained within 2-1/2 hours from INEL.

Since this is a unique facility and the first binary geothermal pilot plant of this type in the country, establishing standard support building costs in order to reduce construction cost seems superfluous. It should be noted that the actual buildings at Raft River are essentially prefabricated structures. Special equipment built in to the buildings, such as control room equipment, chemistry lab equipment, monitoring systems, visitor center and others, have increased the costs and would be unique to this type of facility.

The drilling program at Raft River has been questioned. The first three production wells drilled at the site were successful and are presently estimated to be able to supply the required fluids for the plant (2250 to 2600 gpm at 280°F). The fourth production well consisted of deepening RRGE-4, was not a successful producer, and hydraulic stimulation of the well performed in the last quarter of FY 1979 did not sufficiently improve well production. The fifth production well, RRGP-5, was partially successful. In FY 1980, the well has been hydraulically fractured to increase production. Initial indications are that this well can be used as a back-up supply for the plant and other Raft River experiments. The first injection well, RRG1-6, drilled for the pilot plant was very successful. The second injection well, RRG1-7, was partially successful and will satisfy the plant requirements using higher pressure injection. DOE is also working with the Idaho Department of Water Resources to evaluate the use of spent geothermal fluids to supplement the local irrigation water. Previous studies indicated that this may be an alternative to full injection. This approach would reduce the cost of future low- to moderate-temperature geothermal power plants and add much-needed water for irrigation purposes to most western regions.

The first four wells drilled at Raft River were for reservoir evaluation under the DGE Resources Evaluation Program. The deepening of well RRGE-4 and the subsequent three new wells were drilled under the 5 MWe Raft River Pilot Plant project. No contingency drilling funds were authorized to the field office. It was decided to hold contingency funds for the total hydrothermal program.

Under the Pilot Plant project and the DGE Resource Evaluation Program, Raft River "geological, hydrological, and geophysical data will continue to be gathered in order to fully evaluate the reservoir, determine the long-term well flow rates, and outline the potential of future field development" (5 MWe Pilot Plant Task 64A1180). DGE has an active program with assistance from the State of Idaho and the U.S. Geological Survey to accomplish this objective.

Improvements were needed in the health and safety program. Past problems have been addressed and plans are being developed to improve the program in the future.

Specific reporting requirements beyond the Uniform Contractor Reporting System have been imposed by other DOE organizations, such as the Office of the Controller.

Comments on Specific Findings

Finding No. 1: Project Planning

The present five megawatt Raft River Plant Project initially proceeded without specified and approved goals and objectives. As a result, it is questionable whether the Project can still be considered a "pilot plant project." As the project has expanded its scope, the cost of the project has increased.

Comments

The goals and objectives of the Raft River Project have remained unchanged since it was first approved in 1976. The 40 MW (5 MWe equivalent) Raft River Thermal Loop Facility Project proceeded upon an approved conceptual design and system description as well as Congressional authorization and appropriation of required funding. The addition of a Turbine/Generator to the Thermal Loop Facility Project in FY 1978 was accomplished with appropriate DOE approvals and Congressional authorization and appropriations for the increased scope of work. With the Turbine/Generator addition, the Thermal Loop Facility title was changed and the project was officially entitled 5 MW(e) Raft River Pilot Plant.

The major Systems Acquisition concept and attendant requirements for supporting documentation did not come into being until May 1978; even then it applied to projects of \$50,000,000 or over. On January 22, 1979, construction projects such as the Raft River Facility were directed to develop a project plan and project charter. The requirements for documentation were issued in February of 1979 and the DOE-HQ approved final documents were available in June 1979.

There is some apparent misunderstanding about evolution of the present Pilot Plant and its operation. The scope, concept and operations of Raft River Geothermal Electric Project changed many times during its early formulation days prior to authorization to proceed. An early concept was to construct a 10 MW(e) equivalent plant in cooperation with the Raft River Geothermal Development Cooperative. However, with further study of the technology for binary systems, their efficiency, costs, and the state of development of the well field, a decision was made to construct a 5 MW(e) equivalent unit. The facility would be a 40 MW thermal (5 MW(e) equivalent) Test Loop paid for and operated as a Test Loop by ERDA. The Co-op was to have the option to provide a Turbine/Generator. When the Co-op decided not to provide the Turbine/Generator, then ERDA did. This was a variation on the original theme and total project costs were increased accordingly.

The philosophy of Pilot Plant operation was and still is that the actual engineering testing of the Pilot Plant to verify or qualify prior analytical predictions of the Pilot Plant capabilities and limitations would be performed by EG&G. The actual operations of the plant would be performed by a utility or a utility group. The control room was configured to accommodate this philosophy. When negotiations with a utility group for plant operations and maintenance could not be acceptably concluded in mid-1979, ID did assign responsibility for plant operations and maintenance to EG&G in order to meet DOE programmatic schedules and goals. Negotiations with the utility group are continuing with the chances of success considered highly probable.

From the inception, the Raft River Geothermal Project was intended to be and will be an experimental facility. The utility group should start phase-in as an operating contractor in the near future and take over total operations and maintenance at the completion of the Engineering Testing Period.

Finding No. 2: Facility Design

Design errors and omissions by the architect-engineering firm that designed the Raft River Thermal Loop Facility caused unnecessary costs totaling at least \$113,192.

Comments

ID does not feel that field change costs of \$113,192 on a \$6,678,000 first-of-a-kind construction project to be excessive. This is less than 2 percent of the project cost. In fact, it would be a waste of design funds to try and materially reduce this percentage of error further.

ID upper management did discuss the design errors on this project with the A.E. The conclusion was that the design was reviewed in depth by ID and their support contractor (EG&G) and to put the blame for errors completely on the A.E. or EG&G would be unfair. Because of these facts, it was determined that no action should be taken against the A.E. Recovery of \$113,192 from the A.E. cannot be sustained.

Finding No. 3: Equipment Procurement

The five-ton \$55,000 built-in crane in the cooling water pump house was an unnecessary purchase.

Comments

At the time of the IG's visit to Raft River, the Cooling Water Pump House did not contain any of the water treatment, specifically the large heavy components. ID feels certain that if the IG's inspection were made at this time it would be obvious that the only practical way for removing and reinstalling any one of a number of large pumps and components is by a vertical lift through the maze of piping and conduits. Use of a mobile crane for this purpose would require a multitudes of roof hatches and side doors that would have been more costly than the five-ton bridge crane. Further a mobile crane would be less efficient and operationally more unsafe than the bridge crane.

In regard to lifting and transporting equipment set at the door of the Cooling Water Pump House by the 5-ton bridge crane as well as for removing and handling components and equipment in the process area, there is one 6-ton fork lift, two 12-ton fork lifts, a 12-ton Gallion Crane and trucks at the Raft River Site capable of lifting and transporting most equipment. Any demand for additional equipment can be provided within a matter of a few hours from the large assortment and capacities of equipment located at the Idaho National Engineering Laboratory located approximately 150 miles north of raft River.

Finding No. 4: Facility Construction Costs

Separate support buildings generated unnecessary costs of \$119,000 to \$128,000.

Comments

There was a conscious judgement decision made in the early design phase to separate shop, water treatment and office/control room functions for improved pilot plant operating efficiencies. It was concluded that the additional plant cost would be more than offset by improved working environment, manpower and material flow, and quality of data derived during the R&D testing period. All buildings were designed as minimal cost prefabricated metal buildings. Based upon these facts, this decision was appropriate and cost effective.

Finding No. 5: Geothermal Resource

The geological research for the project's drilling program was inadequate. All geothermal system did not receive total system testing before major construction started. Recent test data shows that the geothermal hot water may not be hot enough to generate electricity economically during the future operational stage.

Comments

The findings in the draft report with respect to the geothermal resources at Raft River are accurate with regard to the general finding that the long-term reservoir testing should be initiated in advance of construction. The discussion, however, contains several inaccuracies which should be corrected. Specifically, the recommendation that "additional basic research be conducted on the region's geology" overlooks the extensive work done by the U.S. Geological Survey since 1973. These studies, with reservoir testing initiated by Lawrence Berkeley Laboratory and continued by EG&G constitute what has been described by the USGS as one of the most complete case studies of a hydrothermal system in the world. This work has continued with a reflection seismic survey of the area which was supervised by the USGS and supported by DOE. A synthesised case study will be published this fiscal year which incorporates this and all previous work on the Raft River area. Additional reservoir confirmation activity to extend the knowledge of the resource beyond the present well field can be accomplished when and if additional drilling is performed.

Finding No. 6: Geothermal Drilling Program

The drilling program which was planned to support the five megawatt Geothermal Plant at Raft River was unrealistic.

Comments

It is simply not true that ID planned for 100 percent success for drilling at Raft River. The first two production wells were drilled in 1975 and the third production well in early 1976. All three wells were successful at producing geothermal fluid which made everyone associated with the drilling pleased and more than a little suprised. At that time it was projected that seven wells would be required for each 5 MW(e) plant---four for production (three on line and one spare) and three for injection (two on line and one spare). With three good producing wells drilled by early 1976, the design of the plant was initiated with the anticipation that of the four remaining wells, at least one would be a producer and perhaps more than one would produce fluid at the required temperature. Then the non-producing wells could be used for injection.

In regard to well costs, well drilling costs escalated at a rate in excess of 25 percent between the time of budget submission and the time well drilling occurred. This resulted in additional costs of approximately \$1.25 million---not several million.

Finding No. 7: Two Facility Construction Safety Hazards

The piping and valves did not have the appropriate number of threads on their bolts and shanks.

Comments

All studs and bolts on above ground piping were installed in a "fit up" condition only. None had been torqued down to the final condition. Inspection has been alerted to insure at least one full thread beyond the nut at the time of acceptance of the piping.

As noted in the recommendations, the sheet metal in the battery room has been replaced with an electrically nonconductive material.

Finding No. 8: Health and Safety Program

Improvements were needed in the health and safety program involving isobutane leaks and the emergency equipment building.

Comments

The following action is planned with reference to isobutane spills and leaks 5 MW(e) Raft River Pilot Plant. The safety analysis report of the 5 MW(e) RRPP will be complete. This report will include discussion of the following:

- a. Description of the facility and process
- b. Identification and evaluation of all hazards
- c. Elimination or minimization of unsafe effects on personnel
- d. Definition of safety limits, design considerations, and administrative procedures necessary to insure safe plant operation

Site and operations personnel as well as the Malta Fire Department will be trained in isobutane related emergency actions and procedures.

The emergency equipment building door has been provided with a locked padlock and with an accessible key enclosed in a breakable glass enclosure nearby.

Finding No. 9: Project Reporting

Excessive reporting of administrative and cost information is consuming a significant amount of critical staff hours that could more profitably be spent on the technical and management aspects of the project.

Comments

Reporting requirements of the Resource Applications Program Office are defined in the approved Project Charter and consists of charts and narrative format suggested by the DOE Uniform Contractor Reporting System (UCRS). Other reporting requirements beyond UCRS are required for other DOE organizations, such as the Office of the Controller. Total reporting requirements in DOE are being examined and duplicate requirement will be eliminated to the extent possible.

Findings Nos. 10, 11, & 12

No comments.

NEGOTIATIONS WITH
GEOTHERMAL POWER DEVELOPMENT GROUP
FOR
OPERATIONS AND MAINTENANCE
OF
5 MWe RAFT RIVER PILOT PLANT

Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

BG-10 9/10/79
Substantive
S. J. J.
AUG 22 1979

Mr. Ronald W. Kiehn
General Manager
EG&G Idaho, Inc.
Idaho Falls, Idaho

Subject: RAFT RIVER 5MW(e) PILOT PLANT - OPERATION AND MAINTENANCE

Dear Mr. Kiehn:

EG&G Idaho, Inc., is hereby assigned responsibility for operation of the Raft River 5MW(e) Pilot Plant. Consequently, that plant is designated under paragraph B.1 of Article II of the prime contract as a facility "to be managed, operated, and maintained by the Contractor." This assignment is in addition to EG&G's present assignments at Raft River and, as such, includes all work necessary to plan, staff, train personnel and prepare appropriate procedures, files and documentation for S.O. and I.P. testing, operation and maintenance of the subject facility through FY-1983.

This assignment should be performed generally in accordance with and within the funding constraints contained in the "Project Management Plan for 5MW(e) Pilot Geothermal Power Plant," dated November 15, 1978; the more recent EG&G-prepared "Operational Plan for the Raft River Geothermal Area," dated April 20, 1979 (revised May 4, 1979); and the Schedule #47, dated March 15, 1979. EG&G should update the Management Plan and submit it to ID for approval. Please provide ID a schedule for the completion of this update.

EG&G is requested to involve electric power utilities and/or other industrial entities in this assignment to the maximum practical extent. EG&G is specifically requested to consider the involvement of the Geothermal Power Development Group and the Raft River Geothermal Development Cooperative, Inc. Please prepare a detailed plan for ID approval for all Raft River Site operations and maintenance activities, and furnish this office with a schedule for the submission of this plan.

Mr. Ronald W. Kiehn

-2-

AUG 3 1979

As previously discussed with your staff, we are also assigning EG&G technical direction of the interim agreement with Geothermal Power Development Group. Wayne Knowles of ID will remain as program manager.

Very truly yours,

Charles E. Williams
Manager

cc: J. W. Morfitt, EG&G
B. G. DiBona, DOE-DGE, HQ
V. V. Johnson, GPDG

JAN 18 1980

INFORMATION MEMORANDUM

TO: The Secretary
Deputy Secretary

THRU: Under Secretary

FROM: Assistant Secretary for Resource Applications

**SUBJECT: Geothermal Power Development Group (GPDG) Operation of
Raft River Geothermal Pilot Plant**

Purpose

To provide the Deputy Secretary with the status of plans for involving the GPDG in the Raft River Pilot Plant operation.

Background

On January 8 and 9, 1980, Bennie G. DiBona, Director, Division of Geothermal Energy (DGE), met with representatives of the DOE Idaho Operations Office (ID), EG&G-Idaho, Inc. (EG&G), and the Electric Power Research Institute (EPRI). The purpose of the meeting was to develop a plan of action for involving the GPDG in the operation of the pilot plant.

During the first day of the meeting, a detailed review was conducted of all geothermal activities in the Raft River Valley, including construction of the 5 MWe pilot plant, operation of the 60 kW binary plant, testing of the production and injection wells, and the status of the direct-heat use experiments. In addition, the history of negotiations between GPDG and DOE-ID was reviewed in an attempt to find possible areas where compromises could be reached and to identify alternative approaches for consummating an agreement with the GPDG.

Discussion

As a result of the meeting, a plan was developed to permit maximum participation of the GPDG in the operation of the pilot plant.

The plan of action includes the following:

1. Meet with GPDG's senior utility executives on February 5, 1980, at Boise, Idaho, to brief them on current project status, outline proposed course of action, and request submission of a new proposal.
2. After receipt of GPDG* proposal in late February or early March, negotiate and execute two agreements. (Agreements with GPDG will require performance guarantee by a member utility.)
 - a. GPDG* begins operation phase-in as soon as possible under a modification to the current technical assistance contract with GPDG. Initiate phase-out of EG&G operation of the pilot plant.
 - b. GPDG* completes phase-in and assumes responsibility for plant operations phase under new agreement between DOE-ID, GPDG*, and EG&G.
3. GPDG* will continue to be involved in engineering, test planning, data analysis, etc., as a member of the utility steering council. This council was recently organized by EG&G to obtain utility input into the project. In the future, EG&G will not be a member of the council, but will act as its executive secretary.
4. DOE will retain full administrative and financial responsibility for plant modifications and operation of the facility, including fluid supply and injection system.
5. The Office of General Counsel has been asked to examine the legal basis for providing GPDG or its designee:
 - a. First right of refusal to buy or lease the plant and associated well field equipment owned by DOE.
 - b. The land on which the surface equipment is located which is presently under Bureau of Land Management control.
 - c. The geothermal resource required for commercial plant operation which otherwise requires competitive bidding for the geothermal leases.

* Or lead utility

Although there has been little progress in the past in negotiating a satisfactory agreement between DOE and GPDG, DGE believes that, with EPTI's help, we should be able to reach an agreement.

While Bennie DiBona was in Idaho Falls, Vasel Roberts (EPRI) and he talked to representatives of Idaho Power and the Raft River Electric Coop (two of the GPDG member utilities), and they are cautiously optimistic that an agreement can be reached. Vasel Roberts will continue to work "behind the scenes" to encourage the member utilities to cooperate during the negotiations.

Signed

Ruth M. Davis

cc:
L. Rawicz, GC

bcc:
ES (4)
RA (1)
DGE (1)

RA-233

Scheve

1/ /8

RA-233

Salisb

1/ /8

RA-233

DiBona

1/ /8

RA-20

Weiss

1/ /80

Prepared by: RA/DGE: MScheve/edr: 633-8110: 1/16/80

FEB 20 1980

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INFORMATION MEMORANDUM

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**TO: The Secretary
Deputy Secretary**

THRU: Under Secretary

**FROM: Assistant Secretary
Resource Applications**

**SUBJECT: Geothermal Power Development Group (GPDC) Operation of
Raft River Geothermal Pilot Plant**

Purpose

To provide the Deputy Secretary with the status of involving the GPDC in the Raft River Pilot Plant operation.

Background

On February 5, 1980, Bennie DiBona, Director, Division of Geothermal Energy, met with representatives of the DOE Idaho Operations Office, EG&G-Idaho, Electric Power Research Institute, and senior executives of the member utilities of the GPDC (see attached list of attendees). The purpose of the meeting was to present a proposal for reopening negotiations with the GPDC and provide for their full participation in the operation of the pilot plant.

After a brief introduction and review of the project status, the proposed course of action was outlined by DOE-ID representatives:

1. Submission of a new technical and business proposal by GPDC to assume full responsibility for plant operation.
2. After receipt of proposal, hopefully by early March, negotiate and execute two contracts. (Contracts with GPDC will require performance guarantee by a member utility, probably Idaho Power.)

- a. First, the existing contract with the GPDG will be modified to provide for phase-in of the GPDG as plant operator as the EG&C operation is phased out. RA-233
DiBona
- b. As this phase-in of the GPDG is completed, a new contract will be negotiated that recognizes GPDG's full responsibility for plant operations and establishes the appropriate DOE, GPDG and EG&C interfaces. 2/ /80
RA-20
Weiss
- 3. Examination by the Office of General Counsel of the legal basis, if any, for providing the GPDG or its designee: 2/ /80
 - a. First right of refusal to buy or lease the plant and associated well field equipment owned by DOE.
 - b. Leases for the land on which the surface equipment is located which is presently under Bureau of Land Management control.
 - c. Leases for the geothermal resource required for commercial plant operation.

Discussion

After the proposal was presented, most of the discussions centered around corporate liability, performance guarantees, GPDG's role as a contractor in a "procurement-type contract", and EG&C's role in the project after plant start-up and testing.

The GPDG did not raise any major issues or problems during the meeting. They were invited to raise any concerns they might have with DOE's proposal.

All of the utility representatives present indicated that they would take our proposal back to their home offices for review and, after discussions between the GPDG member utilities, would get back to us as soon as possible.

Signed

Ruth M. Davis

Attachment

Prepared by: RA/DGE:BGDiBona:mo:633-8909:2-11-80

Retyped: RA/DGE:BDiBona:mo:633-8909:2-14-80

Retyped: RA/DGE;JSalisbury:edr:633-9362:2-15-80

bcc:

ES (4)

RA (1)

DGE (1)

Raft River Pilot Plant Meeting

February 5, 1980

Salt Lake City, Utah

List of Attendees

James Bruce, Idaho Power Company (President)
Bart Kline, Idaho Power Company
L. E. Lanham, Idaho Power Company
Duane Renberger, Washington Public Power Supply System
(Vice President)
Vic Johnson, Washington Public Power Supply System
Boyd Parker, Snake River Power Association
M. Alvin Kempton, Raft River Rural Electric Cooperative
(President)
Bud Tracy, Raft River Rural Electric Cooperative
Golden Gardner, Raft River Rural Electric Cooperative
Charles E. Williams, Idaho Operations Office, DOE
Richard Wood, Idaho Operations Office, DOE
Bennie G. DiBona, Division of Geothermal Energy, RA, DOE
Ronald Kiehn, EG&G-Idaho, Inc. (President)
Vasel Roberts, Electric Power Research Institute

FEB 21 1980

Office of Solicitor
Department of Interior
18th & C Streets, N.W.
Washington, DC 20240

Dear Mr. Solicitor:

The Department of Energy (DOE), through its Division of Geothermal Energy, is currently engaged in the design and construction of a geothermal binary electric pilot plant in the Raft River Valley near Malta, Idaho. The purpose of the project is to demonstrate the economic, environmental, and technical feasibility of generating electricity to a local grid from a moderate-temperature (approximately 300°F) geothermal resource. The plant will be operated for a period of 3 years, starting in October 1980. Upon successful completion of the project in 1983, it would be desirable to have the plant operate as a commercial power plant, continuing to supply electrical power to the local grid. In order to achieve this objective, it would be necessary for a local utility or group of utilities to assume ownership of the plant. Presently we are negotiating with such a group, the Geothermal Power Development Group (GPDG) consisting of the Raft River Electric Cooperative, Inc., Idaho Power Company, Snake River Power Association, Inc., and the Washington Public Power Supply System, to operate the plant during the 3-year evaluation period. This group has requested DOE to allow them to assume ownership of the plant and well field equipment in the future for commercial operation.

I have asked the Department's Office of General Counsel to examine the legal basis for excessing to GPDG the plant and associated well field equipment owned by DOE. The plant and most of the well field equipment are located on land administered by the Bureau of Land Management (BLM). This land is presently being used along with the geothermal resource for the pilot plant under a Cooperative Research Agreement extended yearly between BLM and DOE (See enclosures).

Department of Energy
Washington, D.C. 20461

JUL 8 1980

MEMORANDUM FOR: Deputy Inspector General

FROM: Assistant Secretary for Resource Applications

SUBJECT: Report on the Five Megawatt Geothermal Power Pilot Plant Project

In response to your request, we have reviewed the subject report dated June 19, 1980. We appreciate the positive findings and the constructive suggestions made in your report, but we do not believe that sufficient attention has been paid to our comments on the draft report in preparing the final version. We feel that the comments made on the draft report in our Memorandum of March 19, 1980, and in the Idaho Operations Office (DOE/ID) Manager's Memorandum of March 13, 1980 (attached) are still relevant to your final report. In particular, we continue to take exception to the report's findings with regard to project planning and approval of changes during the course of the project.

The initial detailed Management Plan for the project, dated September 1976, was reviewed by responsible officials at Headquarters. All yearly updates and changes to the plan, including the present revision dated May 1980, have been approved. Final drafts of revisions of the Project Management Plan were delayed in some instances due to format changes, reviewer's comments, and revisions required by Headquarters, but originally drafted plan changes were concurrent with changes in funding and objectives.

Responsible officials at Headquarters have continuously reviewed and approved major changes and decisions in the project from its inception in July 1976 to the present. This has been accomplished not only by detailed program plans and budget reviews and approvals, but more specifically by detailed quarterly review presentations to Headquarters management by the DOE/ID project manager. In addition, responsible officials within the Division of Geothermal Energy have participated in

all plant design reviews and decisions, regarding changes. The Controller's Office of Construction and Facilities Management reviewed the preliminary plant design and budget estimates at DOE/ID in June 1977 and the final design and budget estimates prior to the construction contract award in July 1978. The Assistant Secretary for Energy Technology also held a specific review and approval meeting on the final design, budgets and schedule estimates prior to DOE/ID awarding the contract for plant construction.

On a first-of-a-kind binary geothermal plant at a remote moderate temperature resource site, the performance without prior experience on the part of the DOE project team and its contractors has been very commendable.

Ruth M. Davis

Attachments

cc: Manager, Idaho Operations Office

Department of Energy
Washington, D.C. 20461

MAR 19 1980

MEMORANDUM FOR: Deputy Inspector General

FROM: Assistant Secretary for Resource Applications

SUBJECT: Draft Report on the Five Megawatt Geothermal
Power Pilot Plant Project

In response to your request, we have reviewed the subject draft report and the positive findings contained in the report are appreciated. You requested comments on the accuracy of the draft report and corrective actions taken or planned in response to your recommendations. The attached document summarizes our comments on the draft report for your consideration. It also provides specific comments on each of the findings included in the report, including the corrective actions that have been undertaken.

We understand that the review of the project was accomplished in a very short time. Due to the time constraint, certain documents or discussions may have given the reviewers the wrong impressions. Therefore, we have provided additional information on the history of the project that should be considered in your final report.

Ruth M. Davis
Ruth M. Davis

Attachment: Comments on Draft Report on the
5 MWe Raft River Pilot Plant Project

Prepared by: RA/DGE:MScheve:633-8110:3-12-80

Department of Energy
Washington, D.C. 20585

JUL 7 1980

MEMORANDUM FOR: John K. Mansfield
Inspector General

FROM: *fm* Jack E. Hobbs *MR*
Controller

SUBJECT: INSPECTOR GENERAL REPORT ON THE FIVE MEGAWATT
GEOTHERMAL POWER PILOT PLANT PROJECT

We have reviewed the subject report and find that comments provided by the Assistant Secretary for Resource Applications (RA) on the draft of this report have been attached to the final report but not included in the text. Since there is significant difference between this document and the RA comments, we feel that these issues should be resolved prior to transmittal of this inspection report.

Our specific comments follow:

Finding No. 1 - Project Planning

We are not aware that the goals and objectives of the project have changed as the project evolved. The project has experienced difficulties such as the problem of negotiating an operating contract, addition of a turbine/generator and the land issue, but the goal is the same, namely to demonstrate the feasibility of producing electrical power.

Management of this project was very good as evidenced by the fact that cost, schedule baselines and technical baselines were met. While the report recognizes ID's achievement, it criticizes the management plan developed for the project, specifically the plan used at the outset of the project. At the time this project was initiated, the DOE Project Management system was not in place. Consequently, ID used the Project Management Plan as defined in AEC Appendix 6101. This was a transition project and when the requirement for Project Plans was promulgated in December 1978, ID responded and received approval of the Project Plan for this project in July 1979. From the time the project was initiated in July 1976, throughout the project, the Management Plan was reviewed annually by ID, RA and this office. Progress on this project was continuously monitored by all affected parties.

Finding No. 2 - Facility Design

We concur that the government should seek recovery of costs of errors and omissions due to lack of ordinary skill being practiced by the design firm. Determining responsibility for errors and omissions is very difficult in the best of cases unless the project file is thoroughly documented. It is difficult to assess the skill level of the design contractor without additional data. The number of changes required of the drawings and specifications are not the sole criteria. It should be noted that of the 195 changes, 118 were initiated by the government. There is no way to assess the impact of these changes on the designer's ability to provide a complete and fully coordinated set of plans and specifications.

Finding No. 4 - Facility Construction Costs

The planning of support functions for a project is the responsibility of the field office and the field office staff is in the best position to determine the operational characterization of the space that is required and how the spaces will function to support the goals of the project. In order to support the philosophy of decentralization, the field office must be encouraged to make these decisions without undue interference from Headquarters.

We do not agree that maximum standard unit costs for standard support buildings should be established. The problem of defining a "standard support building" and considering the varying regional, climates and topographical conditions make it virtually impossible to establish a fixed unit cost. We do, however, intend to develop a Cost Factors Manual which will provide cost guidance by building type and will identify geographical differences. This manual will provide a cost range that can be used by the field and Headquarters in determining reasonable costs for various types of facilities.

U.S. DEPARTMENT OF ENERGY
memorandum

DATE: JUL 11 1980

REPLY TO
ATTN OF: PR-222

SUBJECT: DOE-IG Draft Report on the Five Megawatt Geothermal Power Pilot
Plant Projects

TO: IG-2, Deputy Inspector General

We have reviewed the subject report and its recommendations from a contracting standpoint and offer the following comments for your consideration prior to publication of the final report. The type of contract used for procuring A&E services, cost-plus-fixed fee versus firm fixed price, establishes the level of cost risk to be assumed by the A&E firm. In the case covered by your report, a cost-plus-fixed fee A&E contract was used with DOE assuming all of the cost risks within the estimated cost of the contract, except for increased costs resulting from gross negligence on the part of the company's management. The cost of correcting either errors or omissions under a cost type A&E contract ~~are~~ **is** an allowable cost under the contract since the Government assumes all cost risk. Under a cost type contract, the contractor has the right to stop work when available funds under the contract have been depleted even though all of the work is not finished.

Under Finding No. 2, the report addresses the issue of establishing the design firm's liability for damages suffered by the Government because of design errors. For firm fixed price A&E contracts, the DOE-PR's contain a clause in 9-7.802-2 "Responsibility of the Architect-Engineer" under which the A&E agrees to correct any errors or deficiencies without further compensation. Such a provision does not exist for cost reimbursement contracts due to the cost risk assumption by the Government. Assuring quality performance is a Government contract administration function under a CPFF contract, and the contractor is only required to exert its best efforts to accomplish the scope of work within the available funds.

We do not agree with your recommendation that Idaho Operations Office seek recovery of the increased costs caused by alleged design errors and omissions, unless such costs are determined to be unreasonable under the CPFF contract. In the instant case, we agree with the Idaho Operations Office that a design cost deviation of 2 percent of the estimated cost of project construction for changes is not considered unreasonable for a first-of-a-kind construction project. Except for gross negligence on the part of the A&E firm's management, which has not been made evident on the subject project, it is our opinion that provisions establishing A&E liability for damages under a cost reimbursement type contract are not considered compatible with this type of contract. For fixed price type contracts, adequate contract provisions exist to protect our interest, i.e., Responsibility of the Architect-Engineer clause and the termination for default provisions.

We agree that the A&E firm should be involved in construction change orders to determine whether the changes resulted from design errors or deficiencies. This is especially critical for determining a design firm's liabilities under a fixed price contract.

The report appears to be overly critical of the A&E contractor's performance without exploring the impact of the guidance received from another Idaho Operations Office support contractor who may have had substantial involvement in the required modifications and changes.

Bertoni J. Roth
Acting Deputy Director
Procurement and Contracts
Management Directorate