HEBER GEOTHERMAL BINARY DEMONSTRATION PROJECT

QUARTERLY TECHNICAL PROGRESS REPORT FOR THE PERIOD SEPTEMBER 15, 1980 – MARCH 31, 1981

San Diego Gas & Electric
Post Office Box 1831
San Diego, California 92112

**Prepared for
The Department of Energy
Under Cooperative Agreement No. DE-FC03-80RA50239**

MASTER

HEBER GEOTHERMAL BINARY DEMONSTRATION PROJECT

QUARTERLY TECHNICAL PROGRESS REPORT

FOR THE PERIOD

SEPTEMBER 15, 1980 - MARCH 31, 1981

**Date Published
June 1981**

By

**W. H. Hanenburg
R. G. Lacy
G. D. Van De Mark**

DISCLAIMER

This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

**San Diego Gas & Electric
Post Office Box 1831
San Diego, California 92112**

**Prepared For The
Department of Energy
Under Cooperative Agreement No. DE-FC03-80RA50239**

DISCLAIMER

This report was prepared as an account of work performed by San Diego Gas & Electric; sponsored by the Electric Power Research Institute, the Imperial Irrigation District, the California Department of Water Resources, and the Southern California Edison Company, hereinafter called Sponsors; and supported by the U. S. Department of Energy, an agency of the United States Government. Neither San Diego Gas & Electric, nor the Sponsors, nor the United States Government nor any agency thereof, nor any of their employees or subcontractors, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement or recommendation by San Diego Gas & Electric, or the Sponsors, or the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of San Diego Gas & Electric, or the Sponsors, or the United States Government or any agency thereof.

ABSTRACT

The purpose of this first quarterly technical progress report is to document work completed on the nominal 65 Megawatt (Mwe gross) Heber Geothermal Binary Demonstration Project, located at Heber, California, during the period of September 15, 1980, through March 31, 1981. The work was performed by San Diego Gas & Electric Company under the support and cooperation of the U. S. Department of Energy, the Electric Power Research Institute, the Imperial Irrigation District, the California Department of Water Resources, and the Southern California Edison Company. Topics covered in this quarterly report include progress made in the areas of Wells and Fluid Production and Injection Systems, Power Plant Design and Construction, Power Plant Demonstration, and Data Acquisition and Dissemination.

TABLE OF CONTENTS

	<u>PAGE</u>
SUMMARY	1
TECHNICAL PROGRESS	3
INTRODUCTION	3
WBS 1.1 - WELLS AND FLUID PRODUCTION AND INJECTION SYSTEMS	5
WBS 1.1.1 - Design and Construction	5
WBS 1.2 - POWER PLANT DESIGN AND CONSTRUCTION	6
WBS 1.2.1 - Environmental Studies and Permits	6
WBS 1.2.2 - Power Plant Engineering, Design, and Procurement	9
WBS 1.2.3 - Power Plant Construction	15
WBS 1.2.4 - Power Plant Start-Up	16
WBS 1.2.5 - Project Management	17
WBS 1.3 - POWER PLANT DEMONSTRATION	20
WBS 1.3.1 - Demonstration Activities	20
WBS 1.4 - DATA ACQUISITION AND DISSEMINATION	21
WBS 1.4.2 - Data Aquisition, Analysis, and Dissemination	21
FIGURE 1 - ARTIST'S RENDERING	22
FIGURE 2 - PLANT LOCATION	23
FIGURE 3 - FUNDING AND OWNERSHIP PARTICIPATION	24
FIGURE 4 - WORK BREAKDOWN STRUCTURE	25
FIGURE 5 - ERTEC GEOTECHNICAL INVESTIGATION LOCATION OF FIELD ACTIVITY	26
FIGURE 6 - BRINE REQUIREMENTS FOR THE PLANT FOR THE FLOATING COOLING MODE OF OPERATION	27
FIGURE 7 - SIMPLIFIED PROCESS-FLOW DIAGRAM OF THE BINARY CONVERSION SYTEM	28

SUMMARY

Recognizing the desirability of demonstrating the operation of the binary cycle process for commercial-scale electric production, San Diego Gas & Electric Company (SDG&E) has formed a consortium of participant utilities to carry out the Heber Geothermal Binary Demonstration Project. Additional cost-sharing support is being provided by the Electric Power Research Institute (EPRI) and the United States Department of Energy (DOE).

The purpose of the Heber Binary Project is to design, construct, and operate a nominal 65 Mwe (gross) commercial-scale, binary cycle power plant and to demonstrate the technical and economic feasibility of geothermal power generation. The Project will be the first commercial-scale hydrothermal generating facility in the United States utilizing liquid-dominated resources and the first commercial-scale plant in the world using the binary energy conversion process. It is expected that information developed by this demonstration project will be applicable to a wide range of moderate-temperature, low-salinity hydrothermal reservoirs. Geothermal generation from the Project offers the possibility of displacing 525,000 barrels of oil per year that would otherwise have to be burned in Southern California. Figure 1 shows an artist's rendering of the Project and Figure 2 shows the location.

This quarterly report describes progress for the period beginning with the commencement of the DOE/SDG&E Cooperative Agreement on September 15, 1980, and extending through March 31, 1981.

Funding agreements for the Project were executed with DOE, EPRI, and a consortium of utilities (DWR, IID, and SCE), with SDG&E assuming the leadership/management role (See Figure 3).

Contracts were signed for architect/engineer services, geotechnical services, and availability enhancement services. A construction manager is being selected, and bids for the contract are being evaluated.

Various permits were obtained and an Environmental Program Plan was developed to comply with environmental regulations. The required environmental reports were completed and approved.

Negotiations with Chevron Resources Company for the heat sales agreement progressed to the point where the final position of both parties was established. The decision was made by SDG&E not to execute the agreement, in view of the uncertainty of continued federal funding for the Project. San Diego has initiated discussions with Union Oil for the heat sales agreement, with the objective of obtaining more favorable terms and conditions.

The new Reagan Administration budget proposed deleting federal funding for the Heber Binary Project for Fiscal Year 1982. A major effort has been undertaken to persuade legislators of the need for binary cycle technology to be developed on a commercial basis. Both written and oral

testimony has been given to describe the merits of the Project, and all other Project efforts are proceeding based on an assumption of retained federal funding.

Engineering work was initiated on January 5, 1981, by Fluor Power Services. Primary efforts were directed in the following major areas:

- Development of Project Control Documents
This consisted of work on the Quality Assurance Program and Manual and the Project Procedures Manual. The QA Manual was issued to SDG&E in March for the Company's acceptance.
- Preparation of the Project Design Guide
This was the primary focus of the technical effort. Work consisted of reviewing and evaluating the formerly prepared design basis document (EPRI ER-1099) and modifying it to reflect current design conditions and also include additional technical discipline general design criteria. The Design Guide was completed and issued in mid-March 1981 in preparation for the Conceptual Design Review meeting on April 1, 1981.
- Setup of Cost/Schedule Controls
Preparation of budgets in accordance with the work package structure was begun. Also, a preliminary Project Master Schedule and control level schedules for work packages requiring an early start were in preparation.
- Evaluation of Floating Cooling Operation
The study to investigate the utilization of a "floating cooling" mode of operation on plant and equipment performance was completed and issued for SDG&E review and consideration of a revised plant rating.
- Turbine-Generator Specification
Work was initiated on the Technical Specification and also the documentation to comprise the Request for Quotation.

Preliminary discussions began on transmission of power from the Project into the SDG&E system during the demonstration period.

The data management effort to acquire, analyze, and disseminate Project data to a wide audience has been deferred due to the uncertainty of continued federal funding. It is hoped that such a program of sharing data would stimulate commercial development of hydrothermal resources in the United States. Significant progress has been made, however, in drafting the scope of work document, selecting bidders, preparing evaluation criteria, and preparing the bid document.

TECHNICAL PROGRESS

INTRODUCTION

The scope of the Heber Binary Project is to design, construct, and operate a commercial-size, binary cycle geothermal power plant at the Heber reservoir for a two-year demonstration period. The goal of the Project is to demonstrate the technical and economic feasibility, as well as the environmental acceptability, of geothermal power generation using the binary process. Our work plan for the project consists of four major tasks, or Work Breakdown Structure (WBS) elements (see Figure 4), that are described below:

WBS 1.1 - WELLS AND FLUID PRODUCTION AND INJECTION SYSTEMS

Primary responsibility for this task has been assigned to the heat supplier. The task consists of well drilling, the construction of surface facilities for geothermal fluid production and injection, and operation of the field facilities to support plant operation.

WBS 1.2 - POWER PLANT DESIGN AND CONSTRUCTION

This task consists of the work by SDG&E, the architect/engineer, and a construction manager to manage the design, procurement, construction, and start-up of the power plant systems and the associated switchyard, distribution system, and the brine return pipeline. The task includes obtaining necessary permits, associated monitoring, design, procurement, construction, start-up, and project management activities.

WBS 1.3 - POWER PLANT DEMONSTRATION

This task consists of the work by SDG&E to operate the power plant for a two-year period to achieve the basic objectives of the Project. The task includes services, repairs, facilities, overhaul, cleaning, consumables, testing, spare parts, and the tools necessary to operate the plant in a safe and reliable manner.

WBS 1.4 - DATA ACQUISITION AND DISSEMINATION

This task consists of the work by SDG&E and a subcontractor in gathering, reducing, evaluating, and reporting on reservoir and plant performance data.

The WBS will serve several functions. It divides the work into discrete and manageable work packages which, taken in the aggregate, will constitute Project implementation. To some extent, it will dictate organizational lines, and will be an important management tool. It provides a method of accounting for all work that must be performed, and is the basis for manpower loading and scheduling. In addition, it will be used for cost and schedule control and progress audit.

The following describes each subtask objective and status to date.

WBS 1.1
WELLS AND FLUID PRODUCTION AND INJECTION SYSTEMS

WBS 1.1.1 - DESIGN AND CONSTRUCTION

OBJECTIVE:

This WBS element will be performed and funded entirely by the heat supplier. It will include work to design, build, and test production and injection systems necessary to deliver fluid from the reservoir to the power plant and, after use, return the fluid into the reservoir.

STATUS:

- Negotiations with Chevron Resources Company for the heat sales contract progressed to the point where the final position of both parties was established. San Diego decided not to execute the agreement, in view of the uncertainty of continued federal funding for the Project. SDG&E has initiated discussions with Union Oil for the heat sales agreement, with the objective of obtaining more favorable terms and conditions.
- A proposal to evaluate a change in the routing of the injection pipeline was presented. If the modification can be adopted, the cost of the pipeline may be reduced.
- Work on this WBS element will commence with the execution of the heat sales contract.

WBS 1.2
POWER PLANT DESIGN AND CONSTRUCTION

WBS 1.2.1 - ENVIRONMENTAL STUDIES AND PERMITS

OBJECTIVE:

The objective of this WBS element is to obtain the necessary permits and provide environmental studies and monitoring to facilitate plant design and ensure compliance with government regulations for plant construction and operation.

STATUS:

Prior to the signing of the DOE Cooperative Agreement, the following items were accomplished.

- Three permits were obtained from the County of Imperial.
 1. Zone change for Geothermal (G) Overlay Zone of 7,320 acres on the Heber reservoir.
 2. Conditional Use Permit #10-80 to construct and operate the necessary facilities to extract, transport, and inject the geothermal resource.
 3. Conditional Use Permit #8-80 to construct and operate the Heber Binary Plant.
- A water supply agreement was executed on October 18, 1979, between SDG&E and IID, which provides for up to five years supply of fresh Colorado River water for power plant cooling. After five years, the contract provides for a supply of irrigation drain water from IID.
- Permit #18015 was approved on September 5, 1980, by the State Water Resources Control Board for a cooling water appropriation from the New River for SDG&E (along with Chevron Resources).
- Two environmental documents were prepared and certified by the County of Imperial.
 1. Heber Geothermal Demonstration Project Final EIR #170-77, March 1978.
 2. Heber Geothermal Project Final Master Environmental Impact Report #213-79, December 1979.

After the execution of the DOE Cooperative Agreement, the following items were accomplished.

- The final report of the U. S. Water Resources Council, prepared under provisions of the 1974 Federal Nonnuclear Energy Research and Development Act, was completed and transmitted to Charles W. Duncan, Jr., Secretary of Energy, on September 25, 1980. It is an assessment of water requirements and water supply availability for the Project.
- On October 9, 1980, Lynda L. Brothers, Acting Assistant Secretary-Environment, DOE, gave final approval of the Environmental Assessment (EA). The findings of the EA indicated the Project would cause no significant environmental impacts.
- The State Office of Historic Preservation requested and received a copy of the "Archaeological Examination of the Heber Anomaly," which was prepared September 9, 1977, for SDG&E as part of the 1978 Heber Project EIR. On December 16, 1980, the State Historic Preservation Officer concurred with the report's findings that the Project would have no effect on significant cultural resources.
- The U. S. Fish and Wildlife Service reviewed the EA on potential impacts to endangered species from the Project, and on December 24, 1980, concurred that the Project would not affect any sensitive wildlife or plant species.
- On January 7, 1981, the SDG&E Land Department requested the Imperial County Planning Commission to extend Conditional Use Permit (CUP) #227-76, which allows SDG&E to maintain and operate the meteorological tower near the Project site. Public hearings were held and on March 25, 1981, the Planning Commission extended the CUP, which expired March 3, 1981, until March 1988.
- The Request for Proposal (RFP), prepared for the refurbishment of the Heber meteorological tower, received SDG&E approval. Invitations to bid were issued on January 22, 1981, to a list that included several small/minority businesses. On February 3, 1981, bidders were given the opportunity to inspect the Heber site before preparing their bids. A "small business" company has been selected, but contract award is subject to certain requirements being met that deal with tasks to be performed by Union members only. The bidder is attempting to execute a working agreement with the IBEW.
- On February 24, 1981, Fluor Power Services was requested to provide information necessary to prepare applications for an Air Pollution Control District (APCD) Authority to Construct permit and a National Pollutant Discharge Elimination System (NPDES) permit. SDG&E's Licensing & Environmental Department will file for the permits in January 1982, based on information supplied by October 1981.

- An Environmental Program Plan, which covers the following, was prepared and submitted to DOE.

Permit Applications

Meteorological and Air Quality Monitoring Program

New River Flow and Temperature Monitoring Program

Salt Drift Monitoring Program

Chevron Seismic and Subsidence Monitoring Program

New River Study for State Water Resources Control Board

Site Water Table Monitoring Program

- Arrangements have been made to lease continuous temperature recorders from Woodward-Clyde Associates to collect temperature data from the New River near the outfall of the Beech Drain. Delivery of the monitoring equipment is expected by June 1981. W-C will also collect the data from the charts and provide quality assurance.
- During the next reporting period, it is anticipated that seismic monitoring will continue and meteorology and air quality monitoring will begin. The New River Study will be completed. Site water table monitoring and New River temperature and flow monitoring also should begin during the next reporting period.

WBS 1.2.2 - POWER PLANT ENGINEERING, DESIGN, AND PROCUREMENT

OBJECTIVE:

The objective of this WBS element is to prepare engineering and design specifications and procure major equipment to build a nominal 65 Mw (gross) electrical geothermal power plant. Special studies also will be accomplished whenever required.

STATUS:

Three contracts were issued:

- Fugro, Inc. - The geotechnical services contract with Fugro, Inc. was approved by DOE in October 1980 and executed by Fugro in November 1980.
- Fluor Power Services, Inc. - The agreement with Fluor Power Services (FPS) for engineering and procurement services was executed on December 29, 1980. DOE approved the contract on December 23, 1980. An initial meeting was held on January 13, 1981, with FPS, SDG&E, and DOE to review the schedule covering activities from January-March 1981.
- Pickard, Lowe and Garrick - The contract with Pickard, Lowe and Garrick (PL&G) for the Availability Enhancement Program, which will assess and improve the availability of the power plant, was executed on March 26, 1981, and the work is in progress. SDG&E will request DOE ratification.

The following describes work accomplished under each of the preceding listed contracts:

- Fugro, Inc. (presently Ertec Western, Inc.)

Fugro's work covered two areas: a soils investigation to determine the load-bearing capability of the soil; and work to update the seismic criteria developed for the former Heber Project, using data from the October 1979 Imperial Valley earthquake.

All field exploration, including cone penetration tests, drilled borings, installation of piezometers, downhole geophysical tests, etc., was completed by December 1980. The location of field activity is shown in Figure 5. Data interpretation and engineering began, and a draft geotechnical report was issued for incorporation into the Project Design Guide.

The final geotechnical report was issued in May 1981.

• Fluor Power Services, Inc.

Development of Project Control Documents

FPS transmitted the "final draft" of the Project Quality Assurance Manual to SDG&E in mid-March for review and comment. FPS QA conducted an orientation session on the use of quality checklists during a meeting on the turbine generator specification. Further orientation on other QA Program provisions will be conducted after SDG&E acceptance of the Manual.

Work was initiated on a Project Procedures Manual, which will be based on the Job Procedures Manual prepared in the previous FPS/SDG&E work for the Project. Sections of the Manual cover administration, engineering, procurement, and cost/schedule controls.

Preparation of the Project Design Guide

The Project Design Guide was finalized and distributed prior to the Conceptual Design Review meeting on April 1, 1981.

The Design Guide provides the documentation of overall plant objectives, operating philosophy, preliminary design descriptions, design objectives, and criteria. A physical description of the entire facility is included. The Design Guide ensures that all Project participants will utilize the same general basis for engineering and design activities.

Criteria relating to the following categories are provided:

- SDG&E Design Philosophy and Objectives
- Site Information and Criteria
- Civil/Structural/Architectural Design
- Mechanical Design
- Electrical Design
- Process Design
- Instrumentation and Controls Design

The descriptions in the Design Guide are based primarily on the preliminary baseline design and optimization studies in Electric Power Research Institute (EPRI) Final Report, EPRI ER-1099, dated June 1979. Most of the major process design parameters were confirmed for incorporation into the Project Design Guide. These included the binary working fluid composition, brine reservoir, start-of-run and end-of-run temperatures, brine supply pressure, brine return temperature, hydrocarbon turbine throttle conditions, power generator capacity, and cooling water temperatures. The major change was an increase in the brine return pressure from 250 psig to 575 psig to ensure reinjection during plugged well conditions. It was also verified that the Benedict-Webb-Rubin (BWR) equation of state for a supercritical Rankine Cycle will be used to determine sizing parameters for the binary working fluid.

Review and updating of the EPRI ER-1099 document was essentially completed with issuance of the Project Design Guide. Significant changes from EPRI ER-1099 were as follows:

- Evaluations will be made to confirm the use of a digital control system for the power plant operation instead of an analog system.
- The brine return pipeline and brine return pumps will be designed and supplied by FPS rather than the heat supplier. Evaluations will be made after further discussion with the heat supplier to determine the best way to handle the newly required 575 psig (maximum) return brine pressure.
- The electrical HV distribution system is being modified to delete a separate station service transformer for start-up.
- Seismic design will be done with a static analysis following UBC Zone 4 requirements and based on a minimum inertia force of 0.3W.

Other significant or major changes to this baseline information will be incorporated as the design progresses. Comments received as a result of the Conceptual Design Review meeting also will be taken into consideration prior to issuance of the next scheduled update of the Design Guide, planned for July 1, 1981, and on a quarterly basis thereafter. FPS will proceed with design development, assuming no major problems arise from the Conceptual Design Review session.

Setup of Cost/Schedule Controls

Completed a three-month Front-End Schedule.

Issued a preliminary Master Schedule with key milestones covering engineering, design, procurement, construction, and start-up services.

Completed Project Code of Accounts.

Completed and submitted for SDG&E approval schedules and budgets for the following Work Packages:

A001 - A005	Project Implementation Plan
B001 - B006	Project Execution - Management
C001 - C002	Conceptual Design Development
S001	Finance and Project Accounting
T001	Floating Cooling Study

Work in progress includes preparation of schedules and budgets for the following Work Packages:

D001 - D002	Brine and Hydrocarbon System Engineering
E001 - E010	Auxiliary System Engineering
F001 - F002	Site/Plot Plan and Model Development
G001 - G003	Civil/Structural/Architectural Engineering and Design
J001 - J003	Turbine-Generator Engineering
K001 - K006	Piping Engineering and Design
L001 - L004	Electrical System Engineering and Design
M001 - M004	Control Systems (I&C) Engineering and Design
N001	Insulation and Coatings Engineering
P001 - P005	Procurement
Q001 - Q006	Omnibus Activities
R001 - R003	Switchyard Engineering and Design
T002	Long Term Makeup Water Treatment

Evaluation of Floating Cooling Operation

The Project will incorporate a floating cooling cycle instead of the originally planned fixed cooling cycle, since it will permit the optimization of yearly power output by taking advantage of variations in wet bulb temperatures. In contrast, a fixed cooling cycle operates at a constant condensing temperature and delivers constant power during the time that the design wet bulb temperature is not exceeded. By incorporating the floating cooling concept, the plant average efficiency is improved (with a corresponding reduction in brine requirements) while maintaining an average gross power output of 65 Mw. Figure 6 depicts the brine requirements for the floating cooling mode of operation.

In January 1981, after discussions with SDG&E, FPS initiated a study to be done in parallel with EPRI ER-1099 evaluations of "floating cooling" plant operation. This study was prompted by Lawrence Berkeley Laboratory investigations of this mode of plant operations for the Heber Binary Plant. The objective of the FPS study was to evaluate "floating cooling operation," so that a decision could be made on the application of this approach.

Using the EPRI ER-1099 Report as a basis, the cooling water supply temperature was allowed to float, following the actual seasonal wet bulb temperatures. By keeping the cooling water supplied to the hydrocarbon condensers at a constant flow rate, the condensing temperature, and therefore the turbine exhaust pressure, can be decreased as the cooling water supply temperature becomes lower. A lower turbine exhaust pressure will result in increased power generation.

Weather data obtained hourly from the National Oceanic and Atmospheric Administration, taken at the El Centro Naval Air Station from 1945 through 1960, were utilized to develop seasonal wet bulb temperatures. A range of probable turbine exhaust pressures has been given to vendors of radial inflow and axial turbines to determine actual turbine operating conditions.

Data supplied by turbine vendors were used to determine the power output for the floating cooling mode of operation. Brine requirements and cycle efficiencies were determined, the gross and net power output as a function of seasonal wet bulb variation was determined, and delta capital investment for the turbine-generator configurations was estimated.

A preliminary report summarizing the results of the study was issued in March 1981, which indicated that the floating cooling cycle is feasible for the Heber Binary Plant and could provide significantly greater power output and cycle efficiency than the fixed cooling cycle.

Turbine-Generator Engineering

Planning and initial efforts to prepare this key specification were started by Fluor's mechanical discipline. The technical specification was issued for SDG&E review in April.

Power Cycle Conceptual Design

Computer runs were made to generate thermodynamic and physical property data for the 90 mole percent isobutane-10 mole percent isopentane mixture. Preliminary heat and material balances and process flow diagrams for the overall power cycle defined in EPRI ER-1099 were started. Figure 7 is a simplified process-flow diagram of the binary conversion system. Applicable results of this work were incorporated in the Project Design Guide.

Preliminary power cycle equipment selection parameters were established. Conceptual design of the auxiliary systems was started.

Seismic Design Criteria

For the Project, it has been established that all structures and equipment vital to power generation and safety will be designed for a minimum seismic force of $0.3W$ in one direction plus $0.1W$ in the two other perpendicular directions, where W denotes the combined dead loads and live loads during operation.

Electrical System Engineering and Design

The original 1978 one-line electrical diagram in the EPRI baseline report is being re-evaluated in light of the increasing energy costs. It may be possible to reduce energy losses by reconfiguring the one-line diagram. FPS has completed preliminary calculations and evaluations. It appears that constraints as to allowable voltage dip during starting of large motors will largely determine the final design.

Work also was undertaken to provide preliminary electrical system load data to SDG&E in preparation for meetings with IID regarding offsite power system requirements.

Control Systems Engineering & Design

An evaluation is being performed of Distributed Digital Control (DDC) technology for use at Heber in lieu of a conventional analog system. Visits were made to an oil company in Wilmington, California, to become acquainted with their plant control system and assess potential applicability to the Project. DDC has the potential to provide more flexible control capability with lower maintenance costs and higher reliability; it would also permit easy access to plant records for data retrieval and dissemination.

Water Study

Exploratory investigations have been conducted for a long-term source of makeup water to replace the initial Colorado River supply after five years. The study encompassed the heat rejection requirements of the plant, water requirements, environmental constraints, quality and quantity of water available in the area, water treatment requirements, and means of transporting the water to the power plant, as well as a cost estimate for the water treatment facility and transport system. Several alternatives were investigated, including water produced at flash power plants, Alamo River water, All American Canal water, irrigation canal water, Salton Sea water, and New River water. After the results of the study are completed, FPS will be instructed to begin design work on considerations for the water supply.

Pickard, Lowe and Garrick

PL&G developed a work schedule for implementing the Availability Enhancement Program, which was reviewed by FPS.

As requested by SDG&E, FPS Reliability Group generated a set of data for the Heber unit. The data consisted of failure rates and repair times of equipment similar to the type shown in EPRI ER-1099 for the hydrocarbon, cooling water, and brine loop system. The data were reviewed at a February meeting at Irvine with SDG&E, PL&G, and FPS.

PL&G issued a preliminary Availability Data Book, containing analyses of the Heber Binary Plant, based on the EPRI ER-1099 report. A detailed review of this report was conducted by SDG&E, followed by a review by FPS on the appropriateness of the approach used in the analyses. A meeting was held in March with SDG&E, PL&G, and FPS to discuss the impact of the PL&G Availability Data Book. A further definition of the program was accomplished and FPS will review and comment on the PL&G document for conformance to current design intentions. PL&G will update this Data Book, reflecting the newest information in the Design Guide.

PL&G will start preparing availability-related requirements for the hydrocarbon turbine-generator RFQ.

WBS 1.2.3 - POWER PLANT CONSTRUCTION

OBJECTIVE:

The objective of this WBS element for Phase I is to provide construction input to the architect/engineer during the design of the power plant to allow construction in an orderly, cost effective manner. In Phase II, efforts will focus on actual construction of the geothermal binary power plant.

STATUS:

- A Construction Manager will be hired to review engineering design. He will be responsible for dividing construction work into manageable packages and issuing invitations for competitive bidding on lump-sum, fixed-price contracts. He will evaluate the bids received and make recommendations based on his review of them. The Construction Manager also will monitor subcontractors' work, provide reports on subcontractor progress and cash flow to aid in the budgeting process, inspect the subcontractors' work for compliance with engineers drawings, and turn over finished construction to the San Diego start-up team.
- A scope of work document for the Construction Manager was prepared. Potential contractors were interviewed, including Fluor, Parsons, Stone & Webster, Gilbert/Commonwealth, United Engineers and Constructors, Dravo, Lummus, and Bechtel. The RFP was issued in April 1981.
- A study was performed which indicated that the existing IID transmission system will be adequate to handle the construction power requirements. IID has furnished preliminary design information concerning transmission line upgrading, construction and start-up power, and operational requirements.

WBS 1.2.4 - POWER PLANT START-UP

OBJECTIVE:

The objective of this WBS element is to start-up, check-out, and test the completed power plant. This effort shall include the necessary personnel training and the correction of equipment or system problem areas identified during plant start-up.

STATUS:

- A start-up schedule has been developed, with tentative dates for start and completion of plant systems check-out and start-up. A copy of this schedule has been sent to FPS for inclusion in the Project Master Schedule.
- The start-up team for the Project has been defined.
- Work began on the Start-up and Planning Procedures Manual in January 1981.
- SDG&E's Electric Production Department is in the process of obtaining a plant shift supervisor for the Project. This supervisor will work in close coordination with Operation and Start-up Section to review plant systems, train plant personnel, and supply operators during system check-out and start-up activities.

WBS 1.2.5 - PROJECT MANAGEMENT

OBJECTIVE:

The objective of this WBS element is to provide Project management by establishing interfaces and control between SDG&E, the heat supplier, the architect/engineer, other subcontractors, and the Sponsors; defining schedules and reporting progress based on actual accomplishments; finalizing procedures for management, engineering, start-up and design, construction cost and scheduling, accounting, procurement, and reporting; providing cost control by combining estimating, recording, reporting, analyzing, forecasting, and trending of cost data; monitoring work package budget estimates and reporting progress; negotiating and administering Project agreements and contracts; coordinating legal, public information, geothermal heat supply, and procurement activities; and preparing, reviewing, and publishing information regarding the technical status, cost, and schedules of the Project.

STATUS:

- The DOE Cooperative Agreement was executed by SDG&E on September 26 and by DOE on September 27, 1980. A signing ceremony was held October 8, 1980, in El Centro, California, to formalize the Agreement.
- The Participation Agreement between SDG&E and the Electric Power Research Institute (EPRI) was executed by SDG&E on October 3, 1980, and by EPRI on October 21, 1980.
- The Participation Agreement among SDG&E, Imperial Irrigation District, California Department of Water Resources, and Southern California Edison was executed by all parties in early December 1980 and was retroactive to October 1, 1980.
- The first Sponsors' Management Committee meeting was held on December 17, 1980. The Committee approved the Project schedule, goals, objectives, and budget for the Phase I effort.
- On December 1, 1980, an unsolicited proposal was sent to WEST (Western Energy Supply & Transmission) Associates to co-fund the collection and analysis of generic information obtained by SDG&E at the Magma binary cycle pilot plant at East Mesa. The results would be used in the design of the Project. If the proposal is accepted by WEST, their funding level would be \$25,000.
- On December 1, 1980, California Assemblyman David Kelley introduced Assembly Bill (AB) 51, which is designed to appropriate \$8 million from the State's Energy and Resources Fund to assist the construction and demonstration of a commercial-scale, binary cycle geothermal power plant. The Project meets the legislative para-

meters, and such a grant would help reduce SDG&E's financial exposure. Hearings on AB 51 began in early 1981. The bill is being actively supported by the California Public Utilities Commission, the California Energy Commission, and Southern California Edison Company. The bill is now inactive, but a \$2 million appropriation is in both the Senate and Assembly versions of the budget.

- In accordance with the Cooperative Agreement, a Special Bank Account Agreement was signed by DOE, SDG&E, and Bank of America.
- The DOE Letter of Credit was opened at the Bank of America.
- The Advance Waiver of Patent Rights application was granted on October 8, 1980, and the DOE Cooperative Agreement was modified to reflect that.
- Several meetings were held with Barbara Armstrong of the Defense Contract Audit Agency (DCAA) to discuss the audit of SDG&E's accounting practices documentation. Her audit was concluded and the final report was issued in December 1980. The wording of the SDG&E accounting practices, which was submitted to DOE, was revised as necessary to add the clarity desired by the DCAA. There were no changes to basic SDG&E accounting practices.
- Modification #1 to the DOE Cooperative Agreement increasing DOE's funding from \$4,000,000 to \$5,963,509 was executed by SDG&E on February 13, 1981, and sent to DOE for execution.

Work also began on coordinating and developing the necessary data for an amendment (Modification #2) to the Phase I Cooperative Agreement.

- Jim Kerr, SDG&E Supervising Buyer, made a presentation on February 10, 1981, on the Project to a DOE-sponsored minority business seminar in Los Angeles entitled "How To Do Business With DOE Under Public Law 95-507." Several of the attendees expressed interest in the Project, particularly those in engineering and scientific fields.
- A separate SDG&E accounting construction order was created to isolate reimbursements and other credits from the Project costs. This highlights total Project costs on one work order.
- Reporting requirements as set out in the Project agreements (DOE Cooperative Agreement, EPRI Participation Agreement, and Utilities Participation Agreement) are being defined, as well as establishing the scope of each report and who will be responsible for compiling it. The reporting specifications were distributed to SDG&E and its subcontractors.
- The DOE Cooperative Agreement, DOE regulations, and other federal laws were reviewed regarding the obligations of the Project to accommodate handicapped persons. It was determined that the plant should comply with the ANSI standard for handicapped persons.

- On March 16, 1981, R. G. Lacy, SDG&E Project Manager, testified before the House Committee on Science and Technology, Subcommittee on Energy Development and Applications, on the need for continued federal funding of the Project. A week later, testimony also was filed with the House Committee on Appropriations, Subcommittee on Energy and Water Development.
- A conservative schedule for upgrading the IID 34.5 kv transmission line was developed, and will be used in preparation of the line construction agreement with IID. A list of SDG&E Project milestones has been prepared for in-house disciplines.

WBS 1.3
POWER PLANT DEMONSTRATION

WBS 1.3.1 - DEMONSTRATION ACTIVITIES

OBJECTIVE:

The objective of this WBS element is to demonstrate reliable and economic geothermal power generation.

STATUS:

- A meeting was held with SDG&E representatives to discuss plant operations and transmission of power from the Project into the SDG&E system.

WBS 1.4
DATA ACQUISITION AND DISSEMINATION

WBS 1.4.2 - DATA ACQUISITION, ANALYSIS, AND DISSEMINATION

OBJECTIVE:

The overall objective of the data management effort is to acquire, store, evaluate, and report Project data to the energy generation industry and to other parties interested in liquid-dominated geothermal power plant performance. The intended result is to stimulate commercial development of hydrothermal resources in the United States.

STATUS:

- The scope of work document for the data management contract was put in final form, and the following firms were selected to submit bids for the contract: WESTEC Services, Woodward-Cycle Consultants, Science Applications, Stanford Research Institute, and PFR Engineering Systems. Preliminary evaluation criteria were developed in November 1980. The first draft of the Invitation to Bid was prepared, however, solicitation has been delayed because of the uncertainty of continued federal funding.

FIGURE 1
ARTIST'S RENDERING

FIGURE 2
PLANT LOCATION

FIGURE 3
FUNDING AND OWNERSHIP PARTICIPATION

PARTICIPANT	FUNDING PERCENT	OWNERSHIP INTEREST
U.S. Department of Energy	50.0%	—
San Diego Gas & Electric Company	32.8%	86.3%
Electric Power Research Institute	10.0%	—
Imperial Irrigation District	4.0%	10.5%
Southern California Edison Company	2.0%	—*
California Department of Water Resources	1.2%	3.2%
	<hr/> 100.0%	<hr/> 100.0%

*SCE is a Participating Contributor and may assume a prorata ownership share prior to March 31, 1982

FIGURE 4
HEBER BINARY PROJECT
WORK BREAKDOWN STRUCTURE

FIGURE 5
HEBER BINARY PROJECT
ERTEC GEOTECHNICAL INVESTIGATION
LOCATION OF FIELD ACTIVITY

FIGURE 6
BRINE REQUIREMENTS FOR THE PLANT
FOR THE FLOATING COOLING MODE OF OPERATION

NOTES:

- START OF RUN CONDITIONS
- AXIAL TURBINE

FIGURE 7
SIMPLIFIED PROCESS-FLOW DIAGRAM
OF THE BINARY CONVERSION SYSTEM