OTEC SUPPORT SERVICES
QUARTERLY TECHNICAL PROGRESS REPORT #3

15 November 1978 - 14 February 1979

OCEAN SYSTEMS BRANCH
DIVISION OF CENTRAL SOLAR TECHNOLOGY
DEPARTMENT OF ENERGY

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Contract Number ET-78-C-02-4931

28 February 1979

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1.0 INTRODUCTION

Value Engineering Company (Value), under contract ET-78-C-02-4931 with the Department of Energy (DOE) is to provide technical engineering and management support services for the Ocean Thermal Energy Conversion (OTEC) Program of the Ocean Systems Branch, Division of Central Solar Technology. This third Quarterly Technical Progress Report covers the period from 15 November 1978 to 14 February 1979.

2.0 BACKGROUND

The OTEC Program is a research, development, and demonstration effort by DOE to achieve an economically viable ocean thermal power system. The investigation of OTEC has progressed systematically from university studies to baseline platform/plant conceptual and preliminary design studies, and component development and testing. Significant system integration and support services are essential to help DOE bring the OTEC Program to full potential.

To assist in this effort, Value has assembled a team consisting of:

- Value Engineering Company
- Alexander Engineering Company
- Deep Oil Technology, Incorporated
- Evans-Hamilton, Incorporated
- Santa Fe Corporation

Subcontractors or consultants are:

- Chi Associates, Incorporated
- Energy Research and Development International, Incorporated

Dr. V. J. Ciccone
Giannotti and Buck Associates, Incorporated
J. J. McHullen Associates, Incorporated
Dr. R. L. Sullivan, University of Florida
Det Norske Veritas
Capt. R. A. Wilson

This team, under the leadership of Dr. J. P. Walsh, is performing system integration, system engineering, and management services for the Ocean Systems Branch of the DOE.

3.0 OBJECTIVES

These system integration, system engineering, and management services are provided by Value under six general task areas. The task objectives are described below in general terms. Specific detailed work assignments are issued in subtask orders by the DOE Technical Manager, Mr. W. G. Sherwood, of the Ocean Systems Branch.

Task 1 - Survey, Analysis, Evaluation, and Recommendation Concerning Program Performance

This task is for technical analyses and support of current and future program efforts as an aid in developing and evaluating technical program direction. It encompasses the technical assessments of current contracts/grants and proposals for new efforts. Active contribution to the program is by technical assistance and support including recommending statements of work, budgets, schedules, and other supporting documentation such as work breakdown structures.

Task 2 - Program Technical Monitoring

This task is to maintain technical program monitoring to reduce or eliminate negative impacts on cost, schedule, and technical performance. The task includes preparing technical monitoring plans, performing the technical monitoring function, and the integration of independent technical developments so that the evolving technology is commensurate with the program objectives and with design and cost constraints. The task also includes the preparation of material for use in the organization of data and other management information which support ocean platforms and OTEC programs.

Task 3 - Development and Implementation of Methodology to Identify and Evaluate Program Alternatives

This task is to provide methodology to permit the logical and systematic identification, evaluation, and trade-off of program alternatives by DOE, e.g., for such items as the selection of the ocean hull positioning control, cold water pipe, energy transfer, environmental factors, and other major subsystem configurations. This task also includes the implementation of the methodology using inputs from Tasks 1 and 2.

Task 4 - Technical Assessments

As the technical consultant for ocean engineering aspects of the OTEC Program, the OTEC

Project Team will be called upon under this task to perform a variety of technical assessments in areas such as the following:

- Ocean Engineering System Requirements and the Development Program
- Model Tests
- Platform Trade-off Studies
- Reliability Monitoring and Assessment
- Interface Requirements of Vessel and OTEC Related Systems
- OTEC-1 and Pilot Plant Facilities Requirements and Test Programs
- Configuration Management of the Vessel and all Major Subsystems
- Operational and Logistical Support Requirements for the Vessel

Task 5 - OTEC System Integration

Under this task the OTEC Project Team will be called upon to: provide as necessary on-site support at an OTEC contractor's plant, shipyard, and/or operating base for OTEC systems integration, i.e., monitor hardware acceptance and configuration control; provide capabilities for management of the interfaces between all elements of the OTEC system; monitor and evaluate the output of studies pertinent to the OTEC power plant, corrosion, and biofouling; and

evaluate necessary logistics support for the complete OTEC system. They will provide the necessary on-site support, as required, at an OTEC contractor's plant, shipyard and/or operating base to monitor scheduled tests and inspections, certifications, delivery of government furnished equipment and data and perform all required interface functions.

Task 6 - Environment and Siting Considerations

This task provides for technical assistance to DOE in its preparation of the essential environmental and siting data packages in a form amenable to logical site selection(s) and environmental assessments. The task includes assistance in:

- Preparation of environmental and siting scenarios
- Management support in the environmental and siting sub-program element
- Establishment of environmental data requirements
- Selection of siting criteria

4.0

TECHNICAL PROGRESS

4.1 Task 1

Subtask 101 - Performance Survey, Analysis, Evaluation
and Recommendations (Rapid Response)

Accomplishments under this subtask include the following:

Project personnel provided technical assistance and management

support to DOE in developing, guiding, and evaluating direction of technical programs. Attendance at numerous meetings and conferences with DOE officials or contractor personnel served as primary means for providing such support. The creation and/or review of planning documents, such as the work breakdown structure, budgets, schedules, and reports constituted a large segment of the Value Engineering team's contribution to the OTEC effort. Monthly program review meetings at Value ensured a unified team approach to an overview of the OTEC program and the engineering team's support role.

The more significant contributions made in this area are listed below:

- o Various plans were prepared or reviewed by Value Engineering team project personnel. These plans include the following items:
 - o A set of task statements directed towards the development of two acquisition plans for:
 - 1) A utility/user to provide a site for the OTEC 10/40 MW modular experiment , to buy the electricity produced and to share in the cost of acquisition; and
 - 2) a systems integration contractor to design, build, display and operate an OTEC 10/40 MW modular experiment at the specified site. This second acquisition plan is to develop a sequence of com-

petitive designs involving about four prime contractors initially, and eventually leading to one who will build the chosen plant.

- A preliminary draft of a revised environmental package for use in CWP design for Puerto Rico and Brazil offshore areas.
 - A revised Ocean Engineering plan and an associated milestone chart.
 - A plan for a comprehensive system study of the mooring and electric cable for the OTEC ship.
 - Plans for a proposed critical review of the APL plantship and a work statement for this task, to be conducted by DNV. All data, specifications, drawings and calculations relative to the plantship design have been assembled by Value Engineering, and are to be reviewed by DNV as part of this task.
- o The following papers were developed and presented in support of the dissemination of OTEC-related information:
- "An Island Strategy For OTEC Commercialization", presented at the Solar Energy and Conservation Symposium Workshop, Miami, Florida, 11-13 December, 1978. This paper developed a rationale for an island strategy as a means of continuing OTEC development.
 - "Comparative Competitive Cost Data on OTEC",

also presented at the Solar Energy and Conservation Symposium Workshop noted above. The paper synthesized costs for a 400 MW commercial OTEC plant in Hawaii.

- "OTEC Program Status" was presented to the Society for Underwater Technology in London, England. The paper dealt with OTEC planning and progress.

- o Graphic art support has been provided on a continuing basis as requested by the Contracting Officer Technical Representative (COTR). A special concerted effort was expended in the provision of materials for the DOE OTEC Objectives and Status conference. (See Subtask 502).

Subtask 103 - Program Performance Technical Engineering (and Instrumentation Analysis)

Accomplishments under this subtask include the following items:

After the OTEC-1 Preliminary Design Review (PDR) 12-13 December, 1978 the Engineering support team documented comments, questions, and recommendations for the OTEC-1 preliminary design in the areas of instrumentation, power systems, and cold water pipe, based upon the material presented at that review by the systems integration contractor and the major subcontractor. In general, the instrumentation system as described in their preliminary design package was adequate for the OTEC-1, with the first article heat exchanger. It was believed, however, that more work was required to identify sensors which could accurately and reliably measure CWP strain. Also, a review of the CWP strain measurement

techniques as described at the PDR indicated that the techniques were inadequate. Detailed comments were forwarded to the DOE Project Manager for OTEC-1 and DOE Headquarters.

The following subjects relating to testing and instrumentation issues were discussed at meetings and conferences attended and contributed to by project personnel.

- a) Instrumentation of the CWP test on the X-1 platform
- b) Instrumentation and testing of the 10/40 MW platform
- c) Issues relating to the initial deployment of OTEC-1 with the 1 MWe heat exchangers, with the intent of developing a clear list of test and instrumentation priorities.

Subtask 104 - Salinity Gradient Energy Conversion

Accomplishments under this subtask include the following items:

Preparation and planning of a salinity gradient energy conversion contracts review meeting was developed with the assistance of Value Engineering team personnel. A post meeting review was held at which a program study plan and estimated future support, as well as current support requirements, were discussed.

A plan was prepared for reviewing and analyzing a contract awarded for the preliminary design of an osmotic pressure energy converter. An outline was generated for a plan for monitoring progress on this effort.

4.2 Task 2 - Program Technical Monitoring

Subtask 201 - Program Technical Monitoring

Accomplishments under this subtask include the following items:

A rough comparative cost analysis was prepared based on the three PSD-1 final reports for the preliminary design of the OTEC power systems. Data were taken from the recently completed studies by Lockheed, TRW, and Westinghouse. This analysis pointed out a wide variance in costs among the estimates of the three contractors in areas common to all three, such as tanks, generators, ammonia pipes and valves, electrical equipment, the cleaning system, ammonia support, and installation costs.

Various sections of the work breakdown structure dictionary were developed. These sections represent a work definition of each element of the OTEC work breakdown structure which will be used in future studies and designs, as well as in planning.

A biweekly calendar of events, and weekly and monthly progress reports have been prepared and provided to appropriate DOE, NOAA, MARAD, and OTEC support system and subsystem personnel to keep them abreast of achievements, status of subtasks, problem areas, and planned meetings.

Changes to charts and diagrams depicting OTEC organization and planning were prepared and distributed. These included the following items:

- a) The OTEC Ocean Engineering Program Plan (Studies and support)
- b) The OTEC Ocean Engineering Program Plan
- c) The OTEC Systems Development Plan
- d) The OTEC Organization Chart

4.3 Task 3 - Development and Implementation of a Methodology
to Identify and Evaluate Program Alternatives
Subtask 301 - Program Support

Accomplishments under this subtask include the following items:

Engineering and planning support was provided to facilitate the collection of raw data on the polyethylene CWP on MINI-OTEC. These data will include ambient environmental conditions, i.e., sea conditions, driving forces, and meteorology, as well as the response of the CWP to those conditions. Documents detailing instrumentation information were prepared. Investigation of instrumentation plans as formulated by the MINI-OTEC sponsors (state of Hawaii, Lockheed, and Dillingham) and related design concepts were discussed by Value Engineering project personnel, NOAA, and the joint sponsors. Resulting plans for testing and other efforts were coordinated with NOAA.

The Ocean Wave and Ocean Current Bibliography was made available to contractors through the Value Engineering library.

4.4 Task 4 - Technical Assessment

Subtask 401 - 10/40 MW Land-based OTEC Feasibility Study

Accomplishments under this subtask include the following:

All of the necessary technical and cost data for the final report on the feasibility study of the 10/40 MW land-based OTEC plant has been assembled and the report completed. A presentation highlighting the results of the study was presented to DOE by Value Engineering team project personnel. Publication of the report will occur in the immediate future.

Subtask 402 - OTEC Commercial Plant Baseline

Accomplishments under this subtask include the following:

Development of a baseline for the analysis of OTEC commercial plant costing was studied and modifications were suggested, tentative costs have been developed for components common to all three contractors' designs. To accomplish this, structural design criteria, structural loads, and hull weight were compared, and margins, stresses, and design criteria integrated by project personnel. The establishment of a baseline permitted the preparation of a cost reconciliation report dealing specifically with the vessel. Plans have also been formulated for a review of operational support, deployment, and industrial facilities, with all three contractors providing their costing approach data in these areas.

The OTEC construction feasibility study and the land-based OTEC system study, both prepared by Value Engineering team members, were assessed, review comments incorporated, and the reports brought to a state of near-completion. Parts of these reports, which were subsequently presented at the OTEC Objectives and Status Conference (see Subtask 502) were discussed.

4.5 Task 5 - OTEC Systems Integration

Subtask 502 - Systems Integration

Accomplishments under this subtask include the following items:

Systems integration support was provided through preparation and participation in the 23-25 January OTEC Objectives and Status Conference, held at APL. This meeting was an outgrowth of a series of integration meetings held during this quarter with DOE, Value, and APL personnel. This support included organization of the agenda, invitation of attendees, preparation of presentation material for eighteen of the participants, delivery of five presentations by team personnel, attendance and review of all other presentations by team personnel assigned to, and familiar with, the subject material, and participation in a daily follow-up meeting with DOE personnel to review each day's presentations. Handouts which contained copies of the viewgraphed material used with each presentation were prepared and distributed to attendees. Materials received after the meetings were reproduced and distributed as an addendum.

A systems integration presentation was given to the Cold Water Pipe Workshop. Key problems in the CWP technology area were addressed, based on the presentation by workshop personnel.

A preliminary trade-off study was completed for mooring and riser cable systems costs as functions of the mooring watch circle, including the development of a computer program for mooring system analysis and optimization.

A preliminary study entitled "Catenary Mooring Feasibility at Various Potential OTEC Sites" was completed. This study used estimates of environmental loading (wind, wave, and current drag) on two commercial size (400 MW) OTEC ship configurations as developed by Gibbs & Cox, Inc., and Lockheed Missiles and Space Co., for the potential sites of Hawaii, Puerto Rico, New Orleans, and Key West. From these data, the number of mooring lines was estimated and comparisons made between the two configurations and the sites considered. A report will be issued in February.

Subtask 504 - Transmission Cable System Integration

Accomplishments under this subtask include the following items:

A test plan for measuring riser cable mechanical properties with and without an electric load has been developed and is in the final stages of completion.

The final report briefing on Phase I of the riser cable project, presented by the Simplex Wire and Cable Company, was attended and participated in by members of the Value Engineering team. After the meeting, comments were made and recommendations were presented to T. Garrity (DOE) by team personnel.

A report on cable strumming was prepared by project personnel. The study investigated the nature of the vibration problems which strumming causes on the riser portion of the transmission cable. An interim report on the suppression of such strumming was prepared as an addendum to the original report.

4.6 Task 6 - Environment and Siting Considerations

Subtask 601 - Oceanographic Support for Environment

Accomplishments under this subtask include the following items:

Gathering of additional environmental data, specifically, thermal resources and wave and current data for various OTEC sites, has been the subject of extensive investigation. Such information is necessary to support the development of operational and design criteria relative to its environmental effects. Areas such as wave frequency and persistence are being examined.

Biostimulation and the effects of long range toxicity produced by chlorination are being studied.

A number of reports on current-wave coupling were reviewed and commented on.

Revisions and extensions to the Environmental Data Package were completed and distributed.