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OTEC SUPPORT SERVICES
QUARTERLY TECHNICAL PROGRESS REPORT #14

15 August 1981 - 14 November 1981

MASTER

OCEAN ENERGY TECHNOLOGY DIVISION
OFFICE OF SOLAR ELECTRIC TECHNOLOGIES
DEPARTMENT OF ENERGY

Contract Number DE-AC02-78ET21002

VSE CORPORATION

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November 1981

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TABLE OF CONTENTS

<u>SECTION</u>	<u>TITLE</u>	<u>Page</u>
1	INTRODUCTION	1
2	BACKGROUND	1
3	OBJECTIVES	2
4	TECHNICAL PROGRESS	4
	4.1 Task 1	4
	4.2 Task 2	8
	4.4 Task 4	9
	4.5 Task 5	9
	4.7 Task 7	10

1.0 INTRODUCTION

VSE Corporation (VSE), under contract DE-AC02-78ET21002 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 Energy Technology Division, Office of Solar Electric Technologies. This fourteenth Quarterly Technical Progress Report covers the period from 15 August 1981 through 14 November 1981.

2.0 BACKGROUND

The OTEC Program is a research and development 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, VSE has assembled a team consisting of:

- o VSE Corporation
- o Alexander Systems Company
- o Deep Oil Technology, Incorporated
- o Evans-Hamilton, Incorporated
- o Santa Fe Corporation
- o Giannotti and Associates, Incorporated

Subcontractors or consultants are:

- o Energy Research and Development International, Incorporated
- o V. J. Ciccone & Associates, Incorporated
- o John J. McMullen Associates, Incorporated
- o Det norske Veritas
- o Dr. C. L. Cochran
- o Science Applications, Incorporated

This team, under the leadership of J. N. Obradovich, is performing system integration, system engineering, and management services for the Ocean Energy Technology Division of the DOE.

3.0 OBJECTIVES

These system integration, system engineering, and management services are provided by VSE under seven 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. Eugene S. Burcher, of the Ocean Energy Technology Division.

Task 1 - Survey, Analysis, and Evaluation

This task is for technical analyses and support of current program efforts as an aid in evaluating technical program status. It encompasses the technical assessments of current contracts

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 the technical monitoring function, and the integration of independent technical developments.

Task 3 - Development and Implementation of Methodology

This task is to provide methodology to permit the logical and systematic identification, evaluation, and trade-off for such items as the ocean hull positioning control, cold-water pipe, energy transfer, heat exchangers, pumps, turbines, system controls, power-conditioning equipment, biofouling and corrosion countermeasures, 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 is called upon under this task to perform a variety of technical assessments in areas such as the following:

- o Ocean engineering system requirements and the development program
- o Model tests
- o Platform trade-off studies
- o Reliability monitoring and assessment
- o Interface requirements of vessel and OTEC-related systems
- o OTEC-I and Pilot Plant facilities requirements and test programs
- o Configuration management of the vessel and all major subsystems
- o Operational and logistical support requirements for the vessel

Task 5 - OTEC System Integration

Under this task, the OTEC Project Team is called upon to monitor and evaluate the output of studies pertinent to the OTEC power plant, corrosion, and biofouling; and to assure consistency of both performance and cost trade-offs through supporting studies and coordination.

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:

- o Management support in the environmental and siting sub-program element
- o Evaluation of environmental and siting program efforts
- o Integration of technical developments

Task 7 - Transmission Subsystem Considerations

Provide technical assistance to DOE in the analysis of the ocean engineering aspects of OTEC power transmission subsystem development. This task includes assistance in:

- o Development of a methodology for quantifying transmission cable mechanical loads
- o Definition of the developmental testing program necessary to validate cable designs

4.0 TECHNICAL PROGRESS

Technical assistance and management support was provided to DOE in the form of development, guidance, and evaluation of technical programs. Project personnel planned, attended and/or participated in a number of conferences and meetings with representatives of DOE and other agencies and contractor personnel. Such meetings served as the primary means whereby support was provided. A large portion of the program support was applied in the review of program documentation such as plans, budgets, schedules, presentations, literature and reports. A united team approach towards analysis of tasks and provisions of support to meet the needs of the OTEC program has been established at VSE OTEC-team monthly progress-and-evaluation meetings.

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

Subtask 102 - OTEC Commercialization Support

The principal contributions made in this area are as follows:

- o Relative to accomplishments; project personnel —

reviewed the proposed Florida Coastal Management Program Final Environmental Impact Statement. It was recommended that the two Florida OTEC sites, Key West and Tampa, be included in the

document to avoid any future siting conflicts with offshore drilling activities. Once the OTEC sites are included, there should be no objections to acceptance of the document.

analyzed the historical record of the Ocean Thermal Energy Conversion Act of 1980, Public Law 96-320. The analysis was to determine whether the act intends for OTEC to meet less rigorous mortgage-guarantee requirements under Title XI than under the General Fund. The language of the act does not directly confirm this intent, but remarks by several Congressional leaders during hearings and during the passage of the act do show this intent.

worked on three summaries of the Ocean Energy Systems (OES) technology goals for FY 82 and FY 83. Each summary was based on one of the following assumptions:

- 1) money budgeted for OES in both FY 82 and FY 83;
- 2) money budgeted for OES in FY 82 but not FY 83; and
- 3) money budgeted for OES in neither FY 82 nor FY 83.

assembled data and helped write a justification for the funds which were transferred to the International Energy Agency. These funds were for DOE's cooperative role in the development of wave-energy conversion.

compiled and analyzed data preparatory to development of the commercialization section of the OTEC program status report.

edited the FY 80 Program Summary and incorporated recent inputs to contract data sheets. Discussions with DOE personnel indicate that DOE comments on the draft of the summary will be held up until the availability of funding for printing has been determined.

reviewed NOAA's rules and regulations for the licensing of OTEC plants for possible impacts on the OTEC program. No adverse effects are anticipated.

assisted in the preparation and revision of answers to some questions on the Ocean Energy Technology program Sunset Review which is required by Congress. The questions asked about:

- 1) objectives intended for the program and the problem or need which the program was intended to address.
- 2) the degree to which the original objectives of the program have been achieved.
- 3) the effect of the program on the national economy.
- 4) the anticipated needs for accomplishing the objectives of the program.

Subtask 103 - Program Technical Engineering and Instrumentation Analysis

The principal contributions made in this area are as follows:

- o Relative to accomplishments, project personnel —

prepared brief technical summaries for "State-of-the-Art Technical Concerns" relating to the sea water problems of macrofouling and corrosion as encountered in closed-cycle OTEC development. The information is to be used to determine future university-type research efforts.

reviewed descriptive information provided by R&D Associates pertaining to continued development of the mist-flow OTEC process. Final recommendations will not be available until all of the independent reviewers' comments are coordinated.

reviewed technical papers prepared by Japanese authors describing the results of at-sea testing of wave-power generators on "Kaimei." The tests were conducted from September 1979 to April 1980 in the Sea of Japan. Japan, United Kingdom, Canada, Ireland and the United States of America jointly sponsored the tests. A narrative was prepared summarizing the review.

reviewed and coordinated technical reviews of descriptive information proposing the use of electrochemical means to provide biofouling control for OTEC heat-transfer surfaces. The mechanisms by which the proposed electrochemical protection system would prevent biofouling growth were not substantiated by other published studies of biofouling prevention.

prepared a final report of technical investigations into the use of ultraviolet light to prevent biofouling of OTEC heat-transfer surfaces and submitted it for review.

assisted in the revision of planning documents covering accomplishments, objectives, and goals for Ocean Energy Technology programs. The revisions were incorporated to make the planning documents compatible with previously submitted information.

performed and coordinated technical evaluations of descriptive information for a land-based, open-cycle OTEC power plant. This open-cycle system would obtain cold water from 3,000-foot deep coastal wells and warm water from either solar ponds or bottoming-cycle systems. These evaluations determined that further study of the system should not be undertaken because of environmental issues and technical risks associated with development--including the reliability of the cold water source.

completed a technical review of a draft report on heat exchangers with vertical, enhanced, heat-transfer surfaces and prepared comments for use in the final report.

reviewed the preliminary and final reports from Westinghouse on PSD-I and Lockheed on PSD-II and used the data in the reports to calculate weights, heat-transfer areas, and costs to produce 10-MWe evaporators and condensers from titanium. This information on shell-and-tube and plate-type heat exchangers is being incorporated into an

executive summary and status report on the closed-cycle OTEC heat exchanger program. The report evaluates and presents cost data relative to the current best choices for OTEC heat-exchanger configurations and materials to be used in sea water applications.

assisted in the preparation of summaries of the technical problems, accomplishments, and future objectives to reduce technical risks in the development of ocean thermal and wave energy conversion programs. Included with the summaries are recommended plans and programs through FY 83 necessary to resolve the problems identified.

- o Relative to meetings, conferences, etc., project personnel —

attended technical presentations by Aquatics Distributors, Inc. on the following:

- 1) a linear-kinetic cell using magnetic flux to control corrosion and prevent biofouling;
- 2) an electrolytic cell to generate sodium hypochlorite from sea water; and
- 3) an ultraviolet lamp of special design to generate a powerful oxidant called Photozone.

The presentations provided little technical data on or scientific explanation of the functional mechanisms. Additional engineering data have been requested on Photozone.

TASK 2 - Program Technical Monitoring

Subtask 201 - Technical and Management Services

- o Relative to accomplishments, project personnel —

reviewed and prepared comments on sections of Ocean Thermal Energy Conversion Reference Manual, PRC Document No. R-4017.

prepared briefing materials for use in a presentation on U.S.-French cooperation in ocean energy development.

completed the Annual Operating Plan for Energy Transfer Systems for FY 82 and subsequent years.

TASK 4 - Technical Assessments

Subtask 405 - Power System Assessment

The principal contributions made in this area are as follows:

- o Relative to accomplishments, project personnel --

reviewed descriptive information for a proposed land-based, open-cycle OTEC-type power plant. The proposed system would draw cold water from deep coastal wells and warm water from either solar ponds or bottoming-cycle systems.

TASK 5 - OTEC System Integration

Subtask 502 - Systems Integration

The principal contributions made in this area are as follows:

- o Relative to accomplishments, project personnel --

compiled and analyzed data preparatory to development of the stationkeeping section of the OTEC program status report.

compiled data from Argonne National Laboratory on the latest heat-exchanger work for use in developing the power-system section of the OTEC program status report.

completed a preliminary outline of the cold-water-pipe section of the OTEC program status report.

reviewed and assisted in revising Section 6, Alternatives, of the Environmental Assessment for the second deployment of Mini-OTEC. The revisions include updating the deployment schedule and scope of the experiments.

TASK 7 - Transmission Subsystem Considerations

Subtask 701 - Transmission Subsystem

The principal contributions made in this area are as follows:

- o Relative to accomplishments, project personnel --

reviewed and provided comments on background papers describing the energy transfer system. The papers were prepared for use by the Marine Board, Assembly of Engineering, National Research Council in their technical assessment of OTEC ocean engineering technology.

assisted in the preparation of inputs on outyears spending and accomplishments for the OTEC energy transfer system annual operating plan.

reviewed the results and conclusions from fatigue tests of riser-cable components.

reviewed and prepared comments on a draft report of the results from completed tests of candidate OTEC riser-cable samples. The final version of this report was made available in October. It is a report of candidate riser cable characteristics and test program results to date--for use by contractors in the development of pilot plant conceptual designs (Phase I of the OTEC Pilot Plant Program Opportunity Notice).

assisted in preparation of the test plan for the riser cable sleeving tests. These tests were performed to determine the relation between riser-cable armor tension and the amount of load the core can withstand before it is pulled from the casing.

investigated the OTEC riser-cable tensions which result from pitching of the OTEC platform. It was determined that the riser-cable tensions resulting from pitching of the platform are small compared to the tensions due to other platform motions.

- o Relative to meetings, conferences, etc.; project personnel --

presented the preliminary results of the OTEC riser-cable stress analysis at the progress review. The progress review resulted in the initiation of:

- 1) a further investigation of the mechanical properties of lead (the proposed riser-cable sheathing material);
- 2) a review of the frequency spectra being used for mechanical testing of full-scale sections of OTEC-type riser cables; and
- 3) the development of a test protocol for lead and copper samples to be taken from the full-scale test sections.

met with DOE and Simplex Wire and Cable Company to review the status of VSE dynamic analyses of the riser cable, and to assure that test plans will yield results that will enable prediction of actual cable performance.

participated in a riser-cable program progress review at Simplex. A test plan for the sleeving tests was finalized during this meeting.

monitored and critiqued the cable sleeving tests, which were conducted at Preformed Line Products Company in Cleveland, Ohio. The tests were designed to determine the load applied to the conductor which will cause the conductor to move, with respect to the armor, as a function of the tension in the armor. Armor tension ranged from 0 pounds to 200,000 pounds.

visited Simplex Wire & Cable Company to discuss the technical content of a report being prepared at Simplex. The report details progress in the development of the riser cable, and a summary of results of cable development that the pilot plant designers need to conduct the conceptual design.

attended several meetings with DOE representatives to discuss and plan budgets to complete the riser cable development. As a result of these meetings, the development program has been reduced to the minimum program that meets the requirements for the proof-of-concept experiment.

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