7-1-1983

Volume 7, Number 7 (July 1983)

The Solar Ocean Energy Liaison

Solar
OCEAN ENERGY
Liaison

INCORPORATING
The OTEC Liaison

VOLUME 7, NUMBER 7
July 1983

PHASE II AWARD TO OCEAN THERMAL CORPORATION

On May 20th, as the June issue of OE was going to press, the US Department of Energy announced that the Ocean Thermal Corporation (OTC) would be the sole recipient of a contract for Phase II of the US Pilot-Plant Project. In his selection statement, Joseph Tribble, the Assistant Secretary of Energy for Conservation and Renewables, briefly summarized his reasons for selecting OTC over General Electric (GE), the other competitor for the Phase II contract. According to DOE estimates, Phase II will cost around $6.5 million, will last up to 18 months, and will cover the preliminary design of a 40-megawatt prototype OTEC plant for Hawaii.

According to the report, positive aspects of OTC's proposal include the land-based containment structure, a low-risk design that could be fabricated off-site using existing offshore technology; the well-documented and -tested shell-and-tube heat exchangers; the mixed-discharge provision; and the "shirt-sleeves" working environment. DOE also liked OTC's cost assessment and proposed financing plan, which includes a comprehensive analysis of financing options. In general, according to Assistant Secretary Tribble, "OTC's proposal indicates an overall understanding of what is required to undertake and successfully accomplish Phase II."

The Selection Report did, however, point out several weaknesses in OTC's proposal. Specifically, the Report cited problems with the design of the seawater system, including CWP deployment as a major weakness. Other problem areas include inadequate oceanographic and geological data for incorporation into the design process, and the questionable use of a vapor turbine in an off-design mode at the expense of efficiency rather than a properly-sized and -designed ammonia turbine.

The GE proposal, according to the Report, "exhibits few strengths". The platform design is a low-risk, conventional offshore jacket structure using conventional materials and corrosion protection. Capital-cost reductions would be realized through the use of compact, žinc-clad aluminum heat exchangers. GE's proposal to use variable-speed drives to improve plant availability and increase overall efficiency was also cited as a plus. However significant weaknesses were pointed out in the selection statement.

"GE's proposal," according to the Assistant Secretary, "exhibits such major and significant deficiencies that there is little likelihood that GE would be able to accomplish the statement of work elements in a technically satisfactory or timely manner." The Report states that GE did not adequately develop concepts for the CWP, joints, foundations, pipe deployment, and heat-exchanger maintenance. GE's cost estimates were not fully supported, and far exceeded those of the Government. There was no provision for private financing options or a commercialization strategy.

According to the Report, GE does not plan to seek non-governmental sources of financing, and has even maintained that "OTEC plants in the 10-megawatt size range will not become commercial in the near term." The report also contained criticism of GE's management structure.

Copies of the seven-page Selection Report can be obtained by sending $4 (to cover the cost of copying and mailing) to OE. Please include payment.

Tidal Power

TIDAL-POWER PROJECT UNDER WAY IN MAINE

The Passamaquoddy Tribal Council of the Pleasant Point Indian Reservation in Maine applied on June 17th to the Federal Energy Regulatory Commission (FERC) for a license to construct a 12-megawatt (peak) tidal-power plant at Half Moon Cove on Cobscook Bay. In addition to producing electricity for local consumption from a renewable, environmentally-safe source, the plant would serve as a demonstration facility leading to further development of tidal power in the region.

With an average diurnal tidal range of 5.5 meters, the area around Cobscook and Penobscot Bays on the Bay of Fundy has, for the last 60 years, been considered a prime location for tidal-power development. North America's first tidal plant, a 20-megawatt facility located across the Bay of Fundy in Nova Scotia, will begin operation later this year. (See the June 1982 issue of OE.)

(continued on Page 2)

FRENCH OTEC PLATFORM GETS US PATENT

A US patent for an innovative OTEC platform was recently assigned to the Sea Tank Company of Rungis, France. The preferred applications of this design would be for the offshore manufacturing of energy-intensive products.

The semi-submersible platform consists of a concrete base, support columns, and a working deck which remains above the water surface. The structure has open cells for receiving the power modules, which are vertically arrayed to form a cylindrical assembly extending through the support structure. This design facilitates easy removal and installation of the power modules using lift equipment on the working deck. Figure 1 presents an overview of the platform. Figure 2 shows two power modules, one in the operational mode and the other in a half-raised position.

Each module has its own turbine/generator set housed on the working deck for protection and accessibility. The vertical shell-and-tube heat exchangers are located in the modules in the submerged base, evaporator above condenser. Pumps are driven by a common vertical shaft.

The vaporized working fluid exiting

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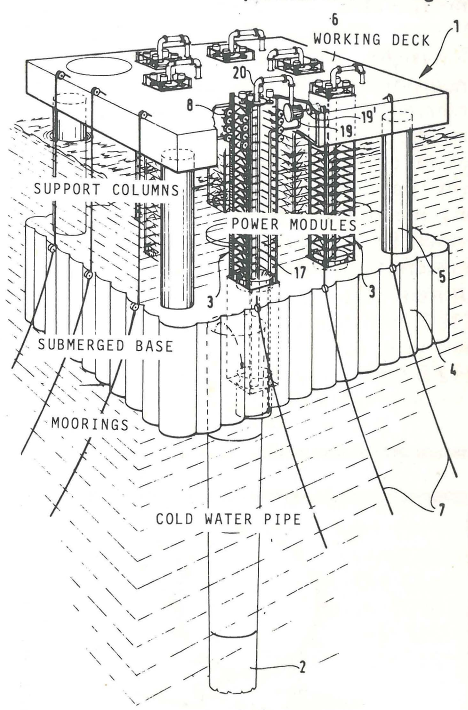

Figure 1. Overview of the patented French platform.

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AN INTERNATIONAL NEWSLETTER ENGAGED AS LIAISON FOR ALL FORMS OF SOLAR ENERGY FROM THE SEA, INCLUDING:
OTEC
(OCEAN THERMAL ENERGY CONVERSION)
WAVE - TIDAL - CURRENT
OFFSHORE WIND - BIOMASS
SALINITY GRADIENTS

VOLUME 7, NUMBER 7
July 1983

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OCEAN ENERGY is published monthly by Popular Products Incorporated at 1303 South Michigan Avenue, Chicago, Illinois 60605, USA. Subscription prices are as listed below: United States and possessions: one year $150, two years $250. Foreign: Add $20 per year for air mail. Single copies: US $12.50 per copy. Foreign $13.75 per copy.
USSN: 0162-8755

SOLAR OCEAN ENERGY

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Technical and economic feasibility studies and preliminary design of the Half Moon Cove project are complete. Final design, financing arrangements, and environmental-impact assessment will be conducted during the licensing period.

The initial tidal plant at Half Moon Cove would be of a single-pool, single-action configuration generating electricity 6 to 7.5 hours per tidal cycle (two per day) on the ebb tide. An expansion plan has been formulated for increasing tidal-power use in the region, including a step-up to a two-pool system. The initial project, however, is discrete; further development will depend on the success of this first venture.

Electricity produced at the plant will be transmitted to the local grid by a 34.5-kilovolt line, 7.1 miles long, which would have to be installed along existing power-line routes.

A clay-core, rock-fill dam will be constructed using local materials at the site of an abandoned highway bridge spanning the cove entrance. The channel which will be blocked by the dam is 366 meters long and 8.2 meters deep. The water-surface area of the cove is now 795 acres at high tide and 290 acres at low tide. Since a 65% reduction in tidal flow will result from the project, the water-surface area at low tide will be increased to 671 acres. However the environmental impact of this modification is expected to be minimal, since no increase in submerged area will result.

Two axial-flow bulb turbines will be installed for a rated capacity of 12 megawatts at a rated head of 14.1 feet and with a rated discharge of 10,015 cubic feet per second. The turbine will have an adjustable blade runner measuring 19 feet in diameter and will rotate at 72 revolutions per minute. The runner blades and the conically-arranged wicket gates are adjusted by an oil-pressure governor to control the unit speed and output while maintaining high efficiencies. The peak turbine efficiency should approach 90% over the operating cycle. The French-built turbines are the same design currently in use at Saint-Malo (Rance), France in the world's first operating tidal-power plant.

The Charles T. Main Company of Boston conducted an economic assessment of the project in 1980 which has been updated to June 1983. The cost and financing parameters are shown in Table 1. Project Director Normand Laberge points out that these are conservative figures, noting for example that the average local customer now pays eight to nine cents per kilowatt hour for electricity.

Several financing alternatives have been identified. Since the Passamaquoddy Tribe have the status of a municipality, they could issue low-interest revenue bonds for some of the financing. A joint private and public venture is envisioned to take advantage of cost-sharing options and the investment and energy-tax-credit incentives. A new road would be built on the dam allowing the redirection of traffic to Eastport away from the Indian reservation desired by the local inhabitants. State and Federal highway funds could thus be used for part of the construction costs. Several other Federal, State, and local funding sources also have been identified.

TABLE 1. PROJECT COSTS AND ECONOMIC ANALYSIS OF HALF MOON COVE TIDAL POWER PLANT IN 1983 DOLLARS

ANNUAL ELECTRICITY OUTPUT	37,280,000 KWH
TOTAL PROJECT COST	$40,072,406
INFLATION RATE (after 6/83)	4.0%
VALUE OF POWER (6/83)	6.0¢/KWH
ESCALATION RATE FOR POWER (6/83-5/87)	4.0%/YEAR
ESCALATION RATE FOR POWER (6/87-12/87)	6.09%/YEAR
ESCALATION RATE FOR POWER (after 1/88)	3.0%/YEAR
INTEREST RATE	8.0%
AMORTIZATION PERIOD FOR LOAN	40 YEARS
OPERATING LIFE OF PLANT	50 YEARS
DISCOUNT RATE	9.0%
YEAR FOR START OF CONSTRUCTION	JUNE 1985
YEAR FOR START OF OPERATION	JUNE 1987
ECONOMIC ANALYSIS	
Total Project Cost	$40,072,406
Adjustments*	$10,884,478
Adjusted Project Cost	$29,187,928
SHORT-TERM ANALYSIS	
Total Annual Cost	$2,616,880
Total Annual Revenues:	
(Power Sales of 37,280,000 KWH at 6¢/KWH)	$2,236,805
Production Cost of Electricity	7.02¢/KWH
LONG-TERM ANALYSIS	
Number of Years to Attain Profit After Placed in Operation	4 YEARS

*Assumes that Federal or private support provides 27.165% of the total project cost in the form of project assistance.

(continued from Page 1)
from the evaporator rises to the turbine. The expanded gas is conducted back to the condenser by a conduit which is coaxial with the pump-drive shaft. A pump at the base of the condenser recirculates the liquid working fluid back to the evaporator.

The cold-water pipe (CWP) discharges into a central cell which is connected to each surrounding power-module cell by conduits. These can be remotely and selectively closed, permitting removal of the power module. Cold water enters the condenser by way of the conduit and is discharged through the base of the power module. Warm water enters the evaporator from the top of the base structure and is discharged into an adjacent cell which is open at the bottom. Figure 3 illustrates the flow of water and working fluid through the system, and presents a more detailed picture of the module-lifting mechanism.

Two alternative CWP connections have been proposed for this platform. In the first design, the CWP is suspended by cables connected to the working deck through a swell-compensating system. An articulated coupling is located at the bottom of the central cell, which is closed off at the top by a watertight door. A suspended, ballasted toroid on the inside of the cell, together with a collar on the outside of the CWP, forms a sealed ball joint. This coupling allows a certain degree of relative movement between the pipe and the platform. Figure 4 is a close-up of this CWP connection.

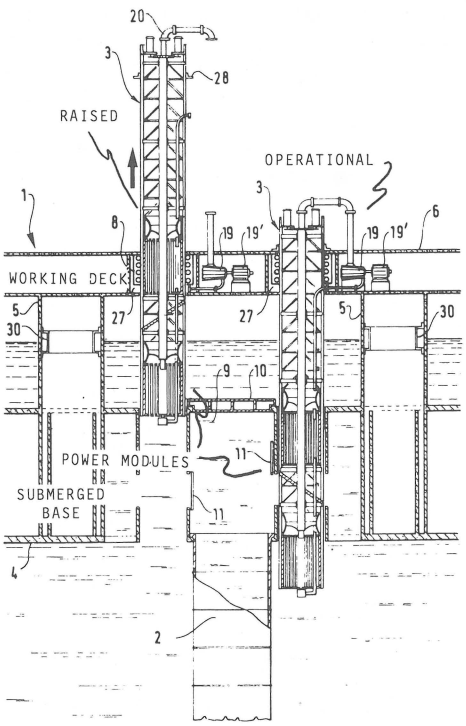

Figure 2. Power modules in the raised position (left) and operational mode (right).

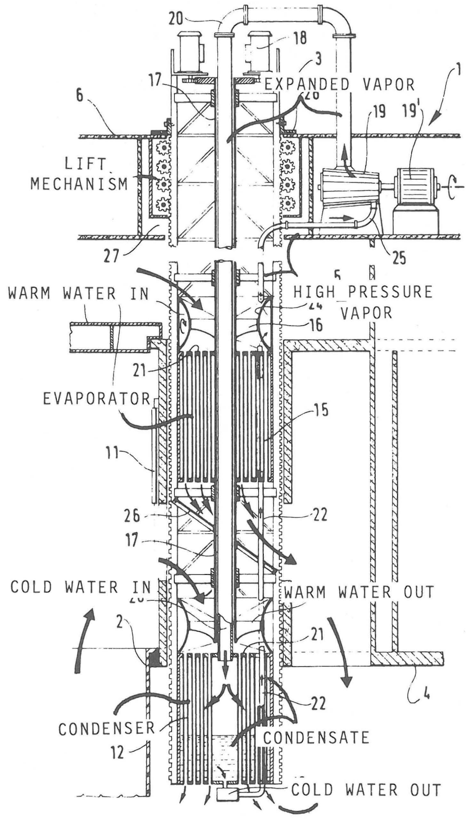

Figure 3. Water and working-fluid paths in the power module, and detail of the lift mechanism.

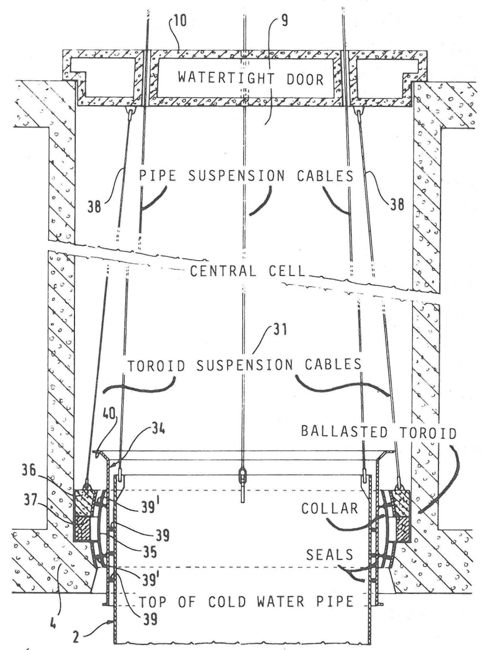

Figure 4. Close-up of the articulated, ball-joint CWP connection.

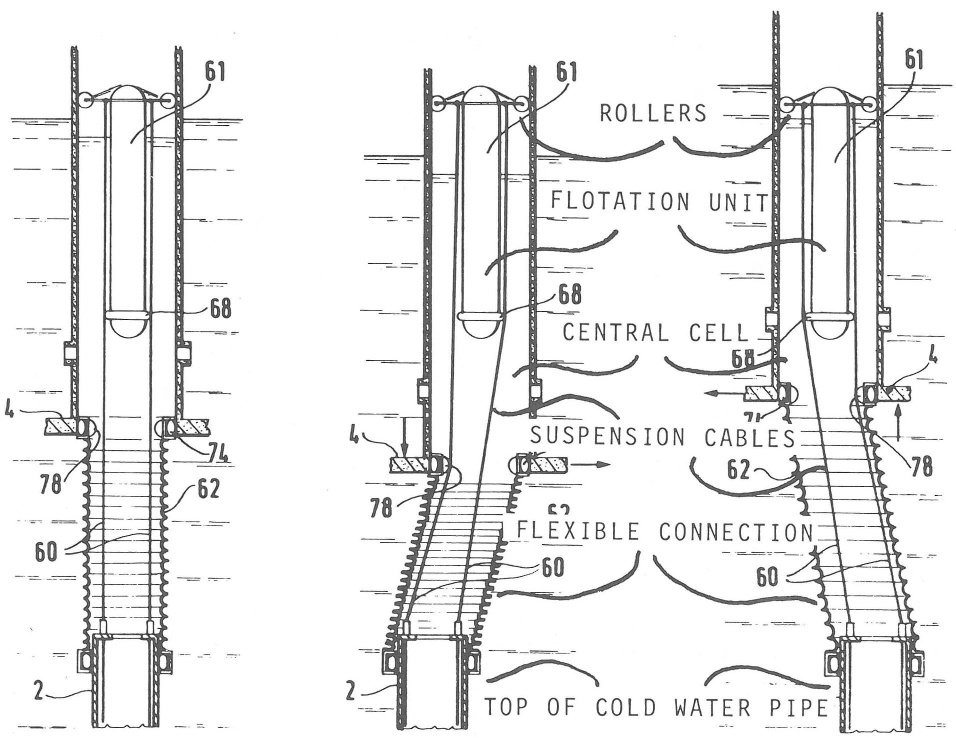

Figure 5. The self-contained CWP connection in three positions.

In the second design the CWP is attached to the platform by a self-contained mechanism whereby all pipe movement is decoupled from the platform. In this design the central cell extends above the water surface and is open to the atmosphere. The self-contained support consists of a flotation unit in the central chamber from which the CWP is hung by cables. Guide rollers keep the flotation unit centered in the chamber. A flexible, longitudinally extensible seal is provided between the top of the CWP and the base of the chamber. As the pipe and platform respond to different environmental forces, the flotation unit will rise and fall, and the accordion-like seal will flex. Figure 5 shows this CWP configuration in three positions.

Copies of the patent document can be purchased from Pergammon International Information Corporation, 1340 Old Chain Bridge Road, McLean, Virginia 22101. Specify the title, "Platform for the Utilization of the Thermal Energy of the Sea", and the number: 4,350,014.

INTERNATIONAL QUARTERLY CALENDAR: 1983-84

Jul 24-28: 21st National Heat Transfer Conference, Orlando, Florida. Sponsors: American Institute of Chemical Engineers and American Society of Mechanical Engineers. Contact: J. Chiffriller, AIChE Meetings Department, 345 East 47th Street, New York, New York 10017.

Aug 15-19: Solar World Congress, Perth, Australia. Contact: Conference Secretariat, Solar World Congress, PO Box X2275, Perth, WA 6001 Australia.

Aug 22-24: IUGG Symposium Number 17: Low-Latitude Coupled Ocean-Atmosphere Circulations, Hamburg, West Germany. Contact: David Halpern, NOAA Pacific Marine Environmental Laboratory, 3711 15th Avenue Northeast, Seattle, Washington 98105.

Aug 21-26: 18th Intersociety Energy-Conversion Engineering Conference, Orlando, Florida: Sponsor: American Institute of Chemical Engineers. Contact: Bill Martini, Martini Engineering, 2303 Harris, Richmond, Washington 99352, phone (509) 375-0115.

Aug 29-Sep 1: Oceans '83, San Francisco, California. Sponsors: Marine Technology Society and Institute of Electrical and Electronic Engineers. Contact: Oceans '83 Technical Program Chairman, PO Box 71030, Sunnyvale, California 94086.

Aug 29-Sep 1: Renewable Energy Technologies Symposium and International Exhibition, Anaheim, California. Sponsors: Renewable Energy Institute and Export Council for Renewable Energy. Contact: TMAC, 680 Beach Street, Suite 428, San Francisco, California 94109.

Sep 6-9: 1st International Energy Exhibition for South East Asia, Asian Energy '83, Singapore. Contact: Peter Teo, ITF PTE Limited, Suite 1103, World Trade Center, 1 Maritime Square, Singapore 0409.

Sep 12-16: 3rd International Conference on Energy for Rural and Island Communities, Inverness, Scotland. Contact. W. Grainger, Energy Studies Unit, University of Strathclyde, 100 Montrose Street, Glasgow, Scotland G4 ONG UK.

Sep 19-23: 12th World Energy Conference, New Delhi, India. Sponsor: World Energy Conference, International Executive Committee. Contact: Robert J. Raudebaugh, 1620 Eye Street, Suite 808, Washington DC 20008, or E. Ruttley, World Energy Conference, 34 Saint James Street, London SW1A 1HD England.

Oct 10-14: Economics Guidelines for Renewable Energy Products Course, Varese, Italy. Sponsor: Ispra Establishment of the Joint Research Centre of the Commission of the European Communities. Contact: Secretariat ISPRA Courses, Centre Comune di Ricerca, I-21020 ISPRA, Varese, Italy.

Oct 18-23: International Show on Techniques and Energies of the Future, Toulouse, France. Contact: Chamber of Commerce and Industry of Toulouse, 2 rue Alsace-Lorraine, F-31002 Toulouse, France.

Oct 31-Nov 2: Global Carbon Cycle: Analysis of the Natural Cycle and Implications of Anthropogenic Alterations for the Next Century, Knoxville, Tennessee. Sponsors: US DOE, Electric Power Research Institute, Gas Research Institute, NOAA, and National Science Foundation. Contact: David E. Reichle, Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, Tennessee 37830.

Nov 7-13: 1st International Exhibition on Alternative and Recyclable Energy Types in Africa, Dakar, Senegal. Contact: EXCAF (Expo Carrefour Afrique), 7 rue de Thiong, BP 1656 Dakar, Senegal.

Nov 30-Dec 2: 6th World Energy Engineering Congress, Atlanta, Georgia. Sponsor: Association of Energy Engineers. Contact: AEE World Energy Congress, 4025 Pleasantdale Road, Suite 340, Atlanta, Georgia 30340.

Dec 12-14: 6th Miami International Conference on Alternative Energy Sources, Miami Beach, Florida. Sponsor: Clean Energy Research Institute. Contact: Dr. T. Nejat Veziroglu, CERI, University of Miami, PO Box 248294, Coral Gables, Florida 33124.

Jan 4-6: 5th Annual International Conference of the International Association of Energy Economists, New Delhi, India. Sponsor: International Association of Energy Economists. Contact: Joy Dunkerley, Resources for the Future, 1755 Massachusetts Avenue Northwest, Washington DC 20036.

Feb 12-16: ASME Energy Sources Technology Conference and Exhibition, New Orleans, Louisiana. Sponsor: American Society of Mechanical Engineers. Contact: Frank Demarest, ETCE, PO Box 59489, Dallas, Texas 75229.

Mar 19-21: 11th Annual Energy Technology Conference and Exposition (ET '84), Washington DC. Sponsors: American Gas Association, Electric Power Research Institute, Gas Research Institute, National Coal Association. Contact: Marvin Heavner, GII, 966 Hungerford Drive, Rockville, Maryland 20850.

OCEANS '83 OTEC SESSIONS

The advanced program of the OTEC sessions at OCEANS '83 is now completed. Paper titles and authors are given below. The two sessions will run consecutively between 1:20 and 5 pm Tuesday, August 30th. Both will be chaired by Joseph R. Vadus of NOAA and co-chaired by Luis Vega of EG&G. Also, a Focal-Programs Session on Mineral Resources and Energy is slated for the morning of Wednesday, September 1st, in which William E. Richards of DOE will present a paper on the US Ocean Energy Technology Program.

For further information and registration materials contact Oceans '83, PO Box 70970, Sunnyvale, California 94086.

FIRST SESSION: US OCEAN THERMAL ENERGY CONVERSION

"The US Department of Energy's 40-Megawatt OTEC Pilot Plant Program: A Status Report": Carmine Castellano, US DOE, and Eric Midboe, Gibbs & Cox Incorporated.

"Design, Fabrication, and At-Sea Test of a Large-Scale OTEC Pipe": Luis Vega, EG&G; Al Kalvaitis, NOAA; and Frank McHale, Hawaiian Dredging and Construction Company.

"OTEC Test Facility for Keahole Point": David Hillis, Herbert Stevens, and Chandrekant Panchal, all of Argonne National Laboratory.

"OTEC Heat-Transfer Experiments at Keahole Point, Hawaii, 1982-1983": Jorn Larsen-Basse, University of Hawaii, and Thomas Daniel, NELH.

"Design of a 160-Megawatt OTEC Plantship for Production of Methanol": William Avery and Dennis Richards, both of JHU/APL.

"OTEC: Prospects for Near-Term Development": Lloyd Lewis, US DOE.

SECOND SESSION: INTERNATIONAL OTEC

"Status of the French OTEC Program": Philippe Marchand, CNEXO, France.

"Evaluation of the Sliding Pressure Operation Based on Test Results of the OTEC Pilot Plant and New Design Concepts", and a movie on the land-based OTEC plant at Nauru: Yasunobu Nakamoto, Toshiro Terayama, and Mikio Takayanagi, all of Toshiba Corporation, Japan.

"OTEC Activities by the Netherlands": Bart J. G. Van der Pot, The Netherlands.

"The 1-Megawatt OTEC Pilot Plant in Jamaica": Torbjorn Berndt, Alfa-Laval AB, and Thomas Högbom, SWECO, Sweden.

"OTEC Technology Development Program in Taiwan, China": Wen Lin and Ke-Kong Hwang of Energy Research Laboratories, Taiwan, China, and Thedore Lee, JKK Look Laboratory, University of Hawaii.

"The Possibility of Using OTEC Systems in Arctic Regions": V. A. Akulichev, A. K. Ilyin, and V. V. Tikmenov, all of the USSR Academy of Sciences.