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Ocean Thermal Energy Conversion Environmental Issues Discussion Paper

September 1980

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

Office of Ocean Minerals and Energy

U.S. National Oceanic and Atmospheric Administration.
Ocean Minerals and Energy.

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Washington, D.C. 20230

OFFICE OF THE ADMINISTRATOR

October 16, 1980

Gentlemen:

The National Oceanic and Atmospheric Administration (NOAA) has been given responsibility for licensing and regulating the ownership, construction, location, and operation of commercial ocean thermal energy conversion (OTEC) facilities and plantships. The statute which conferred this responsibility, the Ocean Thermal Energy Conversion Act of 1980 (Public Law 96-320), requires that licensing regulations be issued by August 1981.

As part of NOAA's efforts to respond to that mandate in an environmentally responsible manner, the enclosed OTEC Environmental Issues Discussion Paper has been prepared. A public "scoping" meeting to assist NOAA in defining the scope of environmental issues associated with commercial OTEC development and to highlight the significant issues to be addressed in preparing licensing regulations will be held as follows:

9:00 a.m. to 12:00 p.m.
Thursday, October 30, 1980
Room 4830
Main Commerce Building
14th and Constitution Avenue, N.W.
Washington, D.C.

I hope that you will take the time to review the Discussion Paper and give us your views, either in person or in writing. Your participation in the early stages of this important new alternative energy program will assist us in meeting our goal of commercial development of OTEC technology with minimum environmental impact.

Sincerely,

R W Knecht

Robert W. Knecht
Director, Office of Ocean
Minerals and Energy

15522

OCEAN THERMAL ENERGY CONVERSION

ENVIRONMENTAL ISSUES
DISCUSSION PAPER

SEPTEMBER 1980

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PREFACE

This discussion paper has been prepared as part of the environmental issues scoping process underway in the National Oceanic and Atmospheric Administration (NOAA) in response to the Ocean Thermal Energy Conversion Act of 1980, Public Law 96-320. The document describes the Act and ocean thermal energy conversion (OTEC) technology in general, gives several projected OTEC commercial development scenarios, and highlights environmental issues associated with that development.

The discussion paper is not a draft environmental impact statement. Rather, it is intended to serve as a brief introduction so that interested parties can better participate with NOAA in identifying the scope of environmental issues and the more significant issues to be addressed in the process of formulating regulations to implement Public Law 96-320.

Interested parties are invited to comment on the discussion paper and to attend and participate in a public scoping meeting to be held as follows:

9:00 a.m. to 12:00 p.m.
Thursday, October 30, 1980
Room 4830
Main Commerce Building
14th and Constitution Avenue, N.W.
Washington, D.C.

Written comments on the discussion paper may also be submitted directly to:

Lowell F. Martin
Office of Ocean Minerals and Energy
National Oceanic and Atmospheric Administration
Room 410, Page Building 1
2001 Wisconsin Avenue, N.W.
Washington, D.C. 20235

Written comments should be provided by November 7, 1980.

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1. PURPOSE AND NEED

1.1. The Law and the Need for Regulations

The Ocean Thermal Energy Conversion Act of 1980, Public Law 96-320, (the Act) sets as its goal establishment of a legal regime which will permit and encourage development of ocean thermal energy conversion as a commercial energy technology. That goal is to be achieved with due regard for other uses of the coastal ocean and high seas and for protection of the marine and coastal environment. The regulations which will be issued by the National Oceanic and Atmospheric Administration, Environmental Protection Agency, Department of Transportation (U.S. Coast Guard), Department of Energy, and other Federal agencies and departments with jurisdiction over ocean thermal energy conversion activities are necessary to meet these objectives.

The Act contains the following principle features:

It directs the Administrator of the National Oceanic and Atmospheric Administration (NOAA) to establish a licensing program governing the ownership, location, construction, and operation of ocean thermal energy conversion (OTEC) facilities and plantships other than demonstration projects so designated by the Secretary of Energy. The program will govern OTEC activities conducted by United States citizens on the high seas and the ownership, construction, and operation of OTEC facilities and plantships documented under U.S. law, located in the territorial seas of the United States, or connected to the United States by pipeline or cable. Regulations establishing the licensing program must be issued within 1 year of enactment of the Act, that is by August 3, 1981. Those regulations must provide for consultation and cooperation with all other interested Federal agencies and departments and with potentially affected coastal States. The views of interested members of the general public must also be considered.

NOAA is further directed to initiate a program to assess the environmental effects of OTEC facilities and plantships. That program must address the short- and long-term effects of individual and multiple deployments of OTEC facilities and plantships, as well as submarine electric transmission cables and other associated equipment located in the water column or on the seabed. Specific areas which must be considered include the nature and magnitude of any oceanographic, atmospheric, weather, climatic, and biological changes associated with OTEC development as a commercial energy technology. The issue of whether or not the potential cumulative environmental effects of OTEC development require placing and upper limit on the number or total capacity of OTEC plants to be licensed must also be addressed.

The Secretary of the department in which the Coast Guard is operating is required by the Act to establish by regulation and enforce procedures with respect to the equipment, training and maintenance required for OTEC facilities and plantships to promote safety of life and property at sea, prevent pollution of the marine environment, clean up any pollutants which may be discharged from OTEC facilities and plantships, and prevent or minimize any adverse impacts from construction and operation of OTEC facilities and plantships. The Secretary is further directed to promulgate and enforce regulations to prevent interference between OTEC plantship thermal plumes and other uses of the territorial seas and natural resources jurisdiction areas of the United States and other nations.

The Act amends The Merchant Marine Act of 1936 (46 U.S.C. 1101) to provide Federal financing assistance for OTEC facilities and plantships. That assistance is to be made available by the Secretary of Commerce to commercial OTEC facility and plantship proposals he finds to be economically sound as well as to demonstration projects certified by the Secretary of Energy to be reasonable risks

with respect to technical and economic viability. A special subaccount of the Federal Ship Financing Fund, to be known as the OTEC Demonstration Fund, is also established to guarantee OTEC demonstration facility or plantship construction loans. An upper limit of $2 billion in outstanding obligations guaranteed under the subaccount is specified.

The Administrator of NOAA and the Secretary of the Department in which the Coast Guard is operating share responsibilities for enforcement of provisions of regulations issued under the Act. The Administrator is charged with establishing compliance monitoring requirements on OTEC licensees. These requirements may include placing Federal officers or employees aboard OTEC facilities and plantships, as well as requiring monitoring of environmental effects of OTEC operations conducted by licensees.

The Secretary of State, in cooperation with the Administrator of NOAA and the Secretary of the department in which the Coast Guard is operating, is charged with conducting international negotiations as necessary to assure non-interference between OTEC facilities and plantships, safety of navigation, and resolution of such other matters regarding OTEC facilities and plantships as need to be resolved by international agreement.

Finally, the Secretary of Energy is charged with responsibility for establishing and enforcing standards and regulations necessary for safe construction and operation of submarine electrical transmission cables and equipment associated with OTEC facilities and plantships. Those regulations must require use of the safest and best available technology for cable shielding, as well as use of automatic current interruption devices.

The full text of the Act is set out in Appendix A. NOAA's present schedule for complying with mandatory deadlines in the statute appears in Appendix B.

1.2. Purpose and Scope of Discussion Paper

This environmental issues discussion paper is not intended to treat exhaustively all potential environmental issues associated with development of OTEC licensing regulations by NOAA. Rather, it is intended to provide an overview of the statutory mandate, the technology, the potential scope of OTEC commercial development, and the environmental impacts projected to occur as a result of commercial development. It is hoped that availability of this paper will assist interested parties in preparing for the scoping meeting on environmental issues to be held October 30, 1980, so that the session will be useful to all concerned with assuring development of commercial OTEC in an environmentally responsible manner.

The environmental impact statement (EIS) which will result from NOAA actions to comply with the National Environmental Policy Act (NEPA) will assess the environmental impacts of development of OTEC as a commercial energy technology under a number of alternative regulatory regimes. The scoping process for which this discussion paper was prepared will assist the NOAA Administrator in determining the scope of issues to be addressed in the EIS and the significant issues related to establishment of a regulatory regime for OTEC licensing. In general, the issues to be addressed will include the projected nature and magnitude of future OTEC development, the local and global environmental impacts of that development; possible ocean use conflicts with shipping, OCS activities, fishing, port access routes, etc.; the energy requirements and conservation potential associated with OTEC development under alternative regulatory regimes; and the level of irreversible or irretrievable commitment of resources associated with the OTEC regulatory regime selected as NOAA's prefered alternative should it be implemented.

1.3. Ocean Thermal Energy Conversion Technology

1.3.1. The concept

Ocean thermal energy conversion is a process for using solar energy stored in warm ocean surface waters to perform useful work. That work may be generation of electricity for domestic and industrial consumption or production of energy intensive products. Two different processes are currently envisioned for use in reducing the OTEC concept to commercial practice, the closed cycle system and the open cycle system.

The closed cycle system uses ocean surface waters warmed by the sun to vaporize a working fluid contained in an enclosed piping system. The vaporized working fluid is passed through a gas turbine that produces rotary motion from the thermal energy imparted to the working fluid. That rotary motion is used to drive an electrical generator or the machinery used to produce a product. After passing through the turbine, the working fluid vapor is cooled and condensed back into a liquid by means of cold water pumped up from the deep ocean. The liquid working fluid is pumped back through the warm water heat exchanger to vaporize it and the cycle is repeated. No fuel in the conventional sense is used. The enclosed working fluid is continually vaporized and condensed by means of the temperature difference between the warm surface waters and cold, deep ocean waters. Figure 1.3.1 shows schematically the closed cycle process.

The open cycle OTEC system operates in much the same way as the closed cycle system except that seawater itself is used as the working fluid. Warm surface water is passed through an evaporator at reduced pressure so that it boils. The produced steam is passed through a turbine to produce rotary motion and is then condensed using cold ocean water drawn up from the depths.

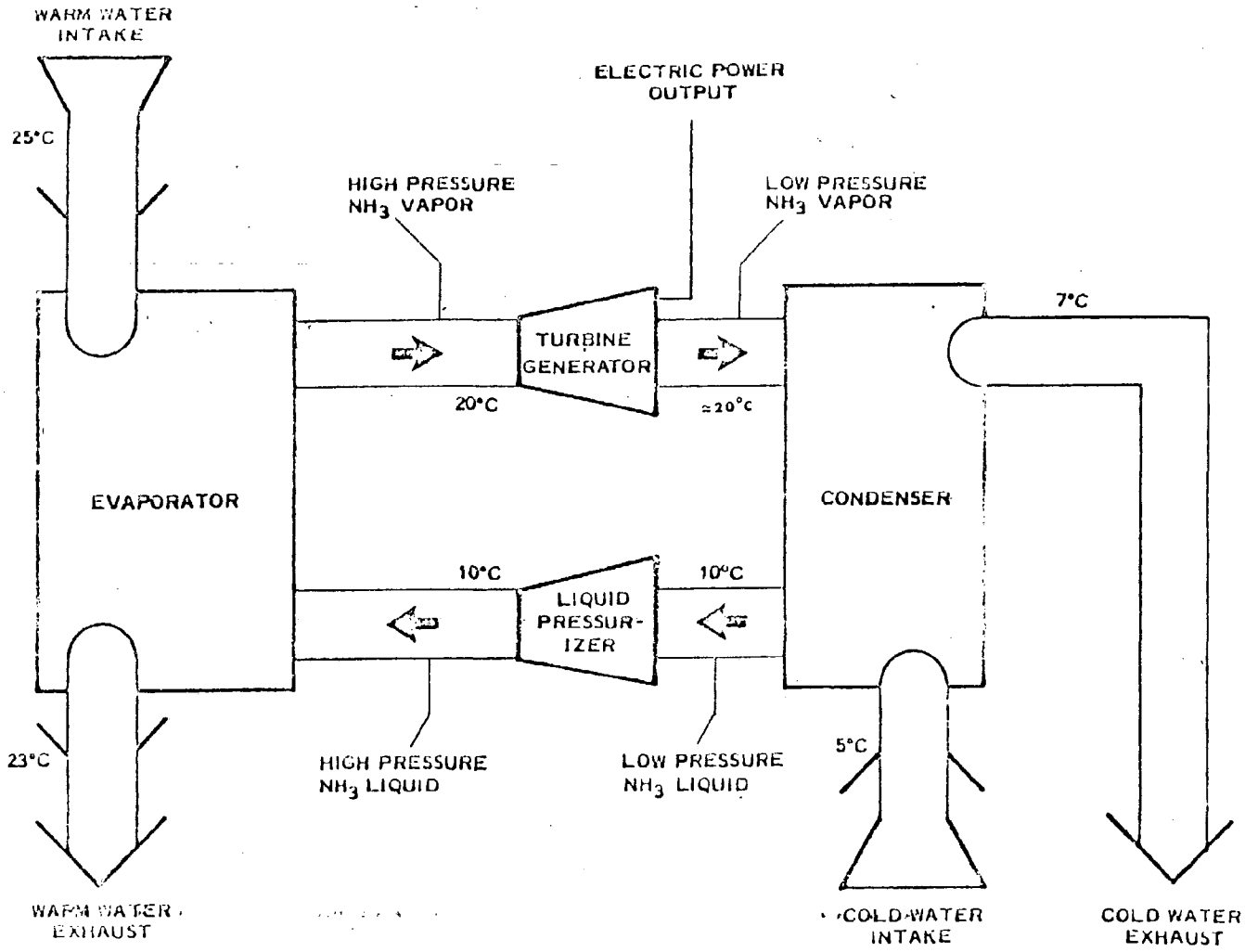

Figure 1.3.1 Schematic Diagram of Closed-Cycle OTEC Power System
Source: DOE, 1979a

Because salt is removed through evaporation, the condensed water from the open cycle process is fresh and constitutes a useful byproduct of the process. However, this distillation effect also results in discharge of seawater with a slight increase in salinity (approximately 1%) over ambient values. To maintain efficiency of the open cycle process it is necessary to remove non-condensible gases, such as oxygen and carbon dioxide, before the water vapor passes through the turbine. This reduces process efficiency and may necessitate discharge of these gases to the atmosphere. Figure 1.3.2 shows schematically the open cycle process.

The first commercial applications of OTEC are expected to use closed cycle technology, although there is considerable interest in commercialization of the open cycle concept because of its inherent freshwater production capability. Because of this likelihood that closed cycle systems will be the first to be licensed for commercial operation, this discussion paper will emphasize issues related to them.

The major subsystems of a closed cycle OTEC facility or plantship which are of concern in addressing environmental issues are as follows:

Heat exchangers - The seawater heat exchangers of primary importance in the closed cycle design are the evaporator, which uses warm surface water to heat and evaporate the working fluid, and the condenser, which uses cold seawater from the depths to cool working fluid vapors after they have passed through the gas turbine and return them to a liquid state. These heat exchangers are one of the most important components of the OTEC system because their efficiency in transfering heat from the water to the working fluid and visa versa will have a significant effect on overall system efficiency. Because of this, control of biofouling of the seawater side of these heat exchangers is a vital system operating parameter. Likely candidate materials for construction

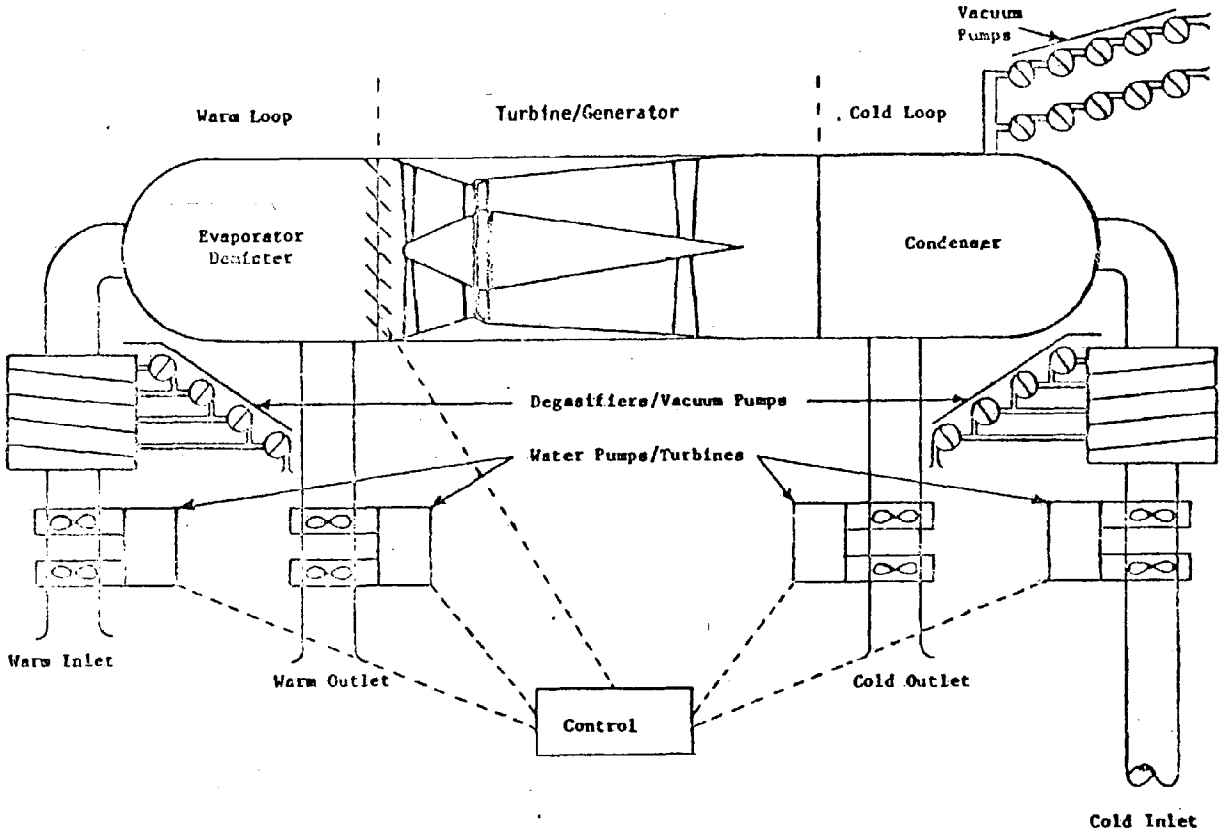

Figure 1.3.2 General System Layout of an Open-Cycle OTEC Plant
Source: Watt et al., 1977

of these heat exchangers are aluminium, titanium, 90/10 copper/nickel alloy, and stainless steel. Approximate seawater surface area requirements for these heat exchangers are 10,000 m^2/MWe (Megawatts electric) of plant capacity. Ten thousand square meters is equal to approximately two and one-half acres.

Working fluid - The working fluid for a closed cycle OTEC plant must have heat transfer and thermodynamic properties suitable for efficient operation. Cost and compatibility with heat exchanger materials are other design considerations. Ammonia (NH_3) is currently the most likely choice as a working fluid. Expected quantities to be required in the closed system are 25 m^3(6,600 U.S. gallons)/MWe of plant capacity. (Open cycle OTEC uses seawater as a working fluid).

Modules/Platform - Rather than relying on two large heat exchangers, several heat exchanger modules will be grouped to make up the OTEC power system for a large commercial plant. This will permit taking portions of the system off-line for cleaning and maintenance while continuing operation. If the OTEC plant is located at sea, a moored or free-floating platform must be provided for the system. The platform must be capable of withstanding the stresses of ocean storms and normal wave-induced motions, as well as stresses caused by movement of water through the system. Several conceptual designs of at-sea OTEC platforms have been completed, including ship, spar/bouy and semi-submersible hull shapes. The OTEC power system equipment (evaporator, turbine, condenser) might also be located on land.

Cold Water Pipe - The pipe used to draw cold ocean water up from the depths is also a critical system element. For a floating application the pipe must be able to withstand the stresses of storms, normal winds, and currents, as well as stresses caused by movement of water through it. Full scale commercial designs of the cold water pipe for 100-400 MWe OTEC plants may be as long as 1,000 meters and as large as 30 meters in diameter. Candidate materials for the

cold water pipe include steel with elastomeric joints and fiberglass. If the OTEC plant is located on land, a submarine pipeline might be used for the cold water pipe. Flow volumes of cold water for closed cycle systems are approximately 3-4 m^3(800-1100 gallons)/second per megawatt of electrical capacity. For a 3-400 MWe commercial plant, the total saltwater flowrate is roughly equivalent to that of the Nile River.

There are three ways in which the OTEC technology may be implemented. The OTEC system may be located on a facility moored to or standing on the ocean floor. Electricity or product from an OTEC facility most likely would be moved to shore via electrical transmission cable or product pipeline. The OTEC power system may be located on land with cold and warm water intakes and discharge piping in the form of moored or seafloor pipelines to the appropriate marine locations. Finally, the OTEC system may take the form of a plantship, a vessel designed to use temperature differences in ocean water while floating unmoored or moving through the water, to produce electricity or directly drive process machinery. OTEC facilities and shore installations would likely be used to produce electricity for introduction into the public utility electrical grid. OTEC plantships will likely be used for production of energy intensive products such as ammonia or for energy intensive processes such as aluminium smelting. Products would be manufactured aboard the plantship as it followed optimum thermal gradient conditions and would be moved from the plantship to shoreside markets by conventional marine transportation modes.

1.3.2. History

The OTEC concept has been in existence for a number of years. Several other nations have explored the possibilities of commercializing the technology in the past. The French funded a large scale OTEC development project for awhile in the 1930s. However, it was later abandoned. Recent realization that the world

is rapidly depleting its oil reserves, coupled with large oil price increases, has renewed interest in OTEC.

Recent U.S. developments include deployment of Mini-OTEC and the pending deployment of the OTEC-1 engineering test facility. Mini-OTEC is an experimental, barge-mounted, closed cycle power system with cold water pipe. The Mini-OTEC project was initiated in September 1978 by a consortium including the State of Hawaii, the Lockheed Missiles and Space Corporation, Alfa-Laval and Dillingham Corporations. Mini-OTEC was successfully deployed several kilometers off Keahole Point, Hawaii in August 1979. A 50-kilowatt design, Mini-OTEC's generator ran two 20 horsepower seawater pumps and produced slightly in excess of 10 kilowatts of net electric power. A second deployment is currently planned to be undertaken with support by the U.S. Department of Energy.

The OTEC-1 engineering test facility has been developed as part of the Department of Energy program to successfully demonstrate commercial scale OTEC technology. OTEC-1 is a Navy Reserve Fleet tanker, the USNS CHEPACHET, which has been modified to serve as an operational test facility for closed cycle OTEC power cycle components such as heat exchangers, pumps, cold water intake pipes and working fluid systems. It has the capability of testing components at the one megawatt (1,000 kilowatt) electrical capacity level. The planned operating site is 30 kilometers northwest of Keahole Point, off the Kona Coast of Hawaii. Deployment is scheduled for the late fall of 1980.

Consistent with the accelerated development and commercialization schedule mandated by the OTEC Research, Development and Demonstration Act of 1980, Public Law 96-310, the Department of Energy (DOE) has issued a Program Opportunity Notice for design, construction, deployment, operation, and evaluation of a closed cycle OTEC pilot plant with a net capacity of at least 40 megawatts electric (MWe). The OTEC pilot plant program will progress from conceptual design through five

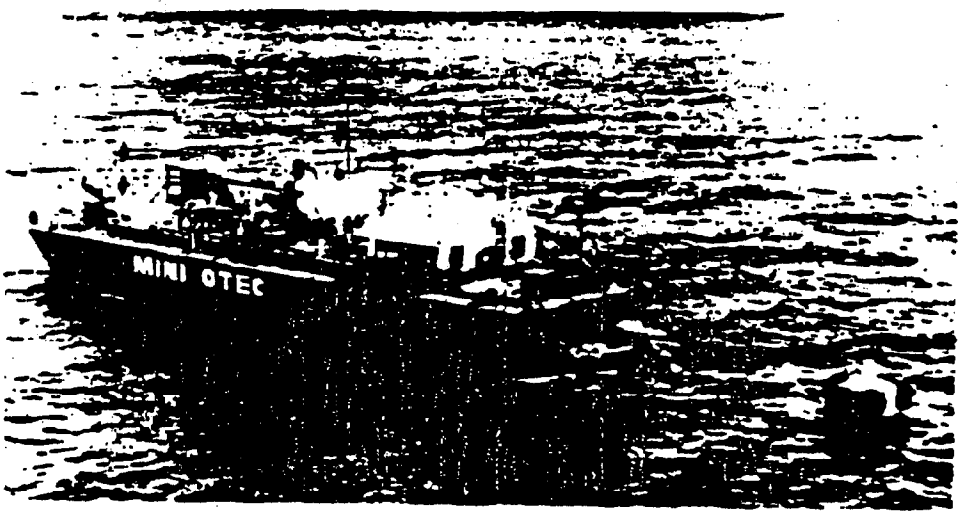

Figure 1.3.3 **An Aerial View of Mini-OTEC in Operation.**

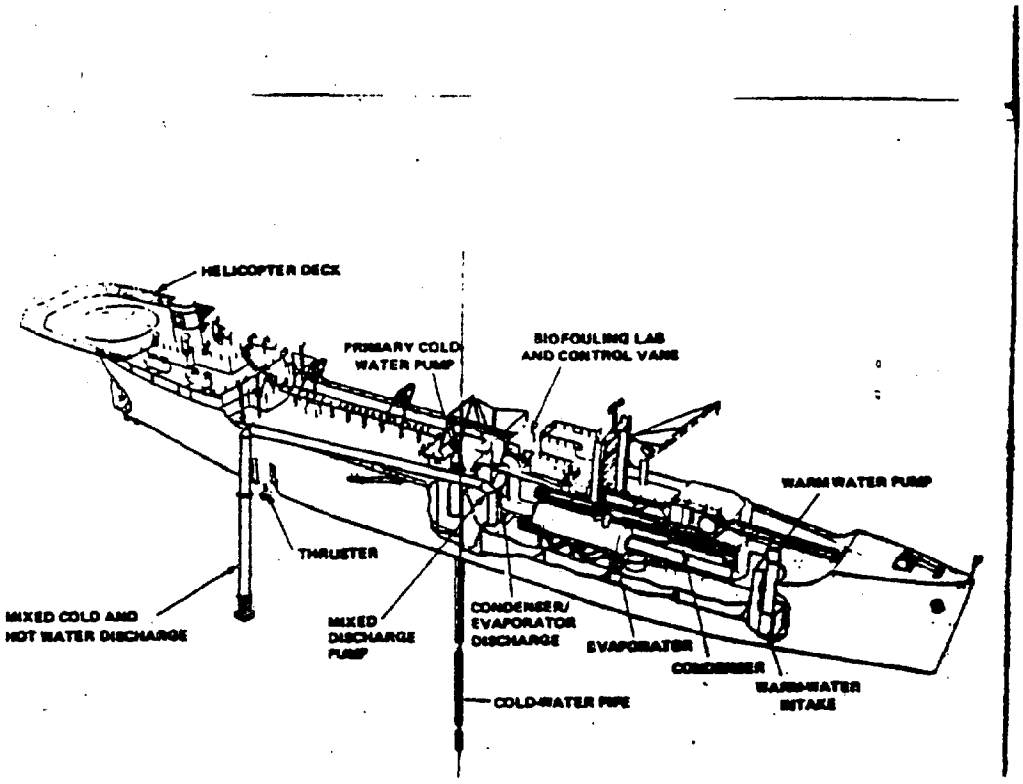

Figure 1.3.4 Artist's Conception of OTEC-1

additional phases culminating in deployment and long-term commercial operation of at least one 40 MWe closed cycle OTEC plant. The current schedule for the DOE pilot plant program calls for construction to begin in mid calendar year 1984, with at-sea operational test and evaluation starting in mid 1986.

1.4. The Thermal Resource and Potential Future Development

The minimum temperature difference between surface waters and the deep ocean which allows efficient OTEC operation is approximately 20° C. A temperature difference of that magnitude is generally available between the surface and a depth of 1,000 meters in a band between 20 degrees north latitude and 20 degrees south latitude, as shown in figure 1.4.1. An adequate thermal resource for OTEC plant operation tends to be available within 10 kilometers of tropical U.S. islands where water depths reach 1,000 meters. Figure 1.4.2 shows thermal resource availability for Hawaii and Puerto Rico, as well as the Gulf of Mexico.

U.S. island sites are likely candidates for early commercial OTEC development. This is due to nearshore availability of the thermal resource, which reduces electrical transmission cable costs. Another factor is the near total dependence of U.S. islands on imported oil for energy needs. Each megawatt of annual electricity demand met by OTEC would eliminate the need to import 40 barrels of oil per day. For example, if Puerto Rico's current average annual use of 2,000 megawatts were derived from OTEC, the need to import 80,000 barrels of oil per day would be eliminated.

Another potential area for early commercialization is ammonia production on OTEC plantships. A large portion of U.S. ammonia production is used in manufacturing fertilizer. The feedstock currently used for shoreside ammonia production is natural gas. An OTEC ammonia production plantship would rely on hydrogen produced from seawater as a feedstock. A 325 megawatt ammonia production plantship would be capable of producing 1,000 metric tons of ammonia per day. Each such plantship would eliminate the need for 12 billion cubic feet per year of natural gas as ammonia production feedstock. Current annual U.S. natural gas production is about 20 trillion cubic feet. Thirty such 325 megawatt plantships would be required to meet projected post 1985 increases in U.S. fertilizer demand.

LARGE SCALE DISTRIBUTION OF

OTEC THERMAL RESOURCE

ΔT(°C) BETWEEN SURFACE AND 1000 METER DEPTH

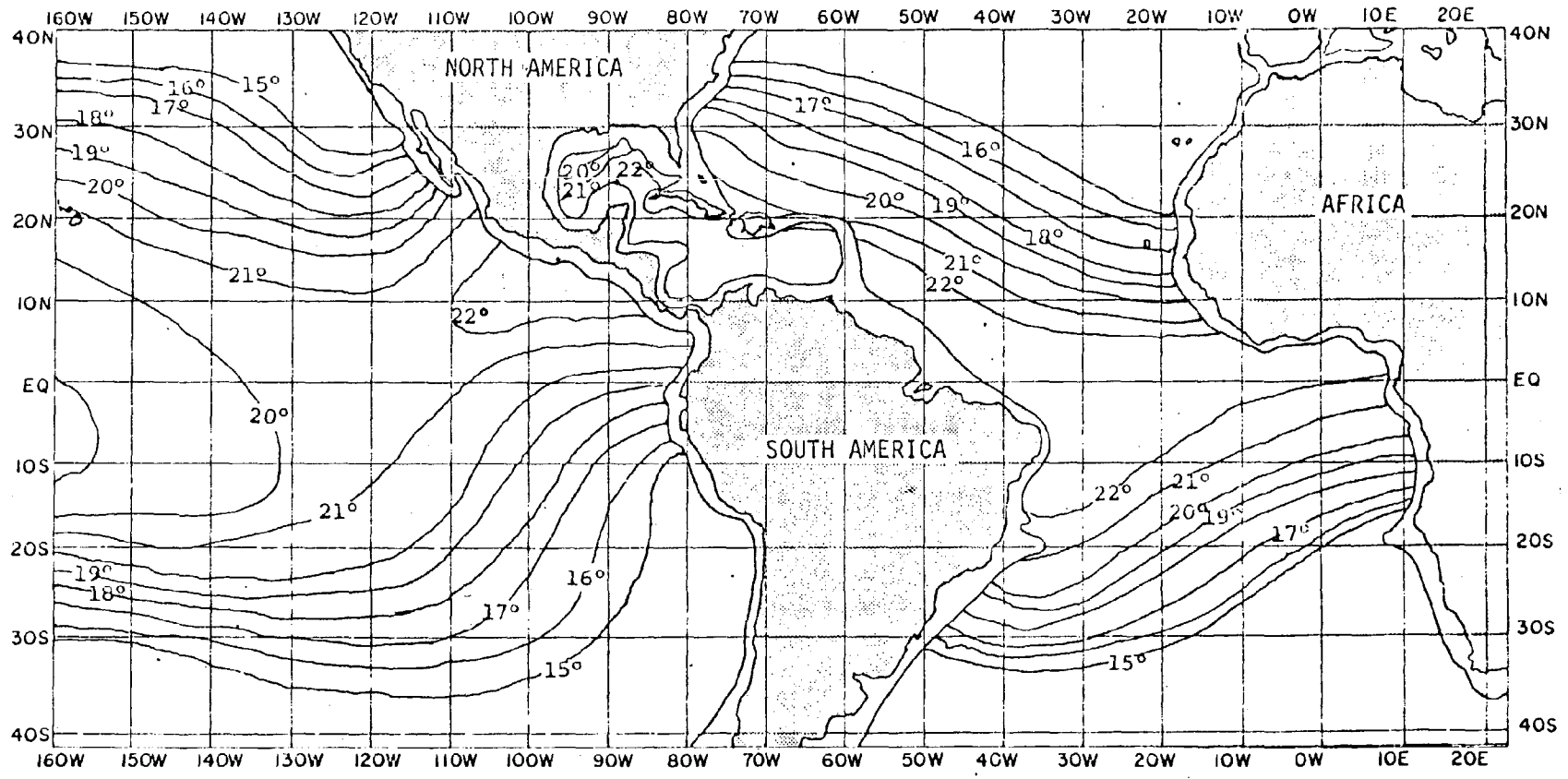

Figure 1.4.1 World's Thermal Resource
Source: U.S. DOE, 1978

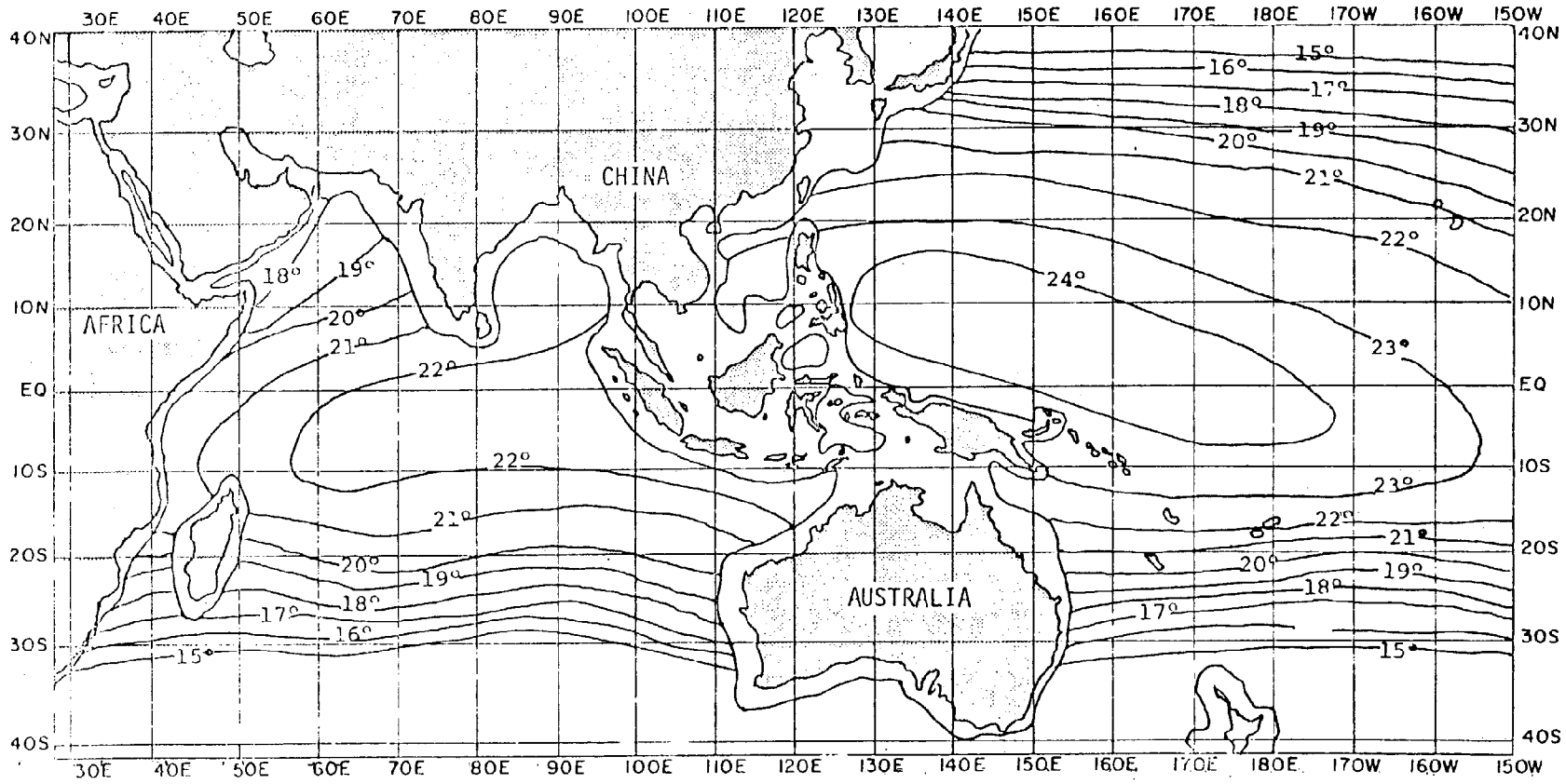

Figure 1.4.1 (Continued)

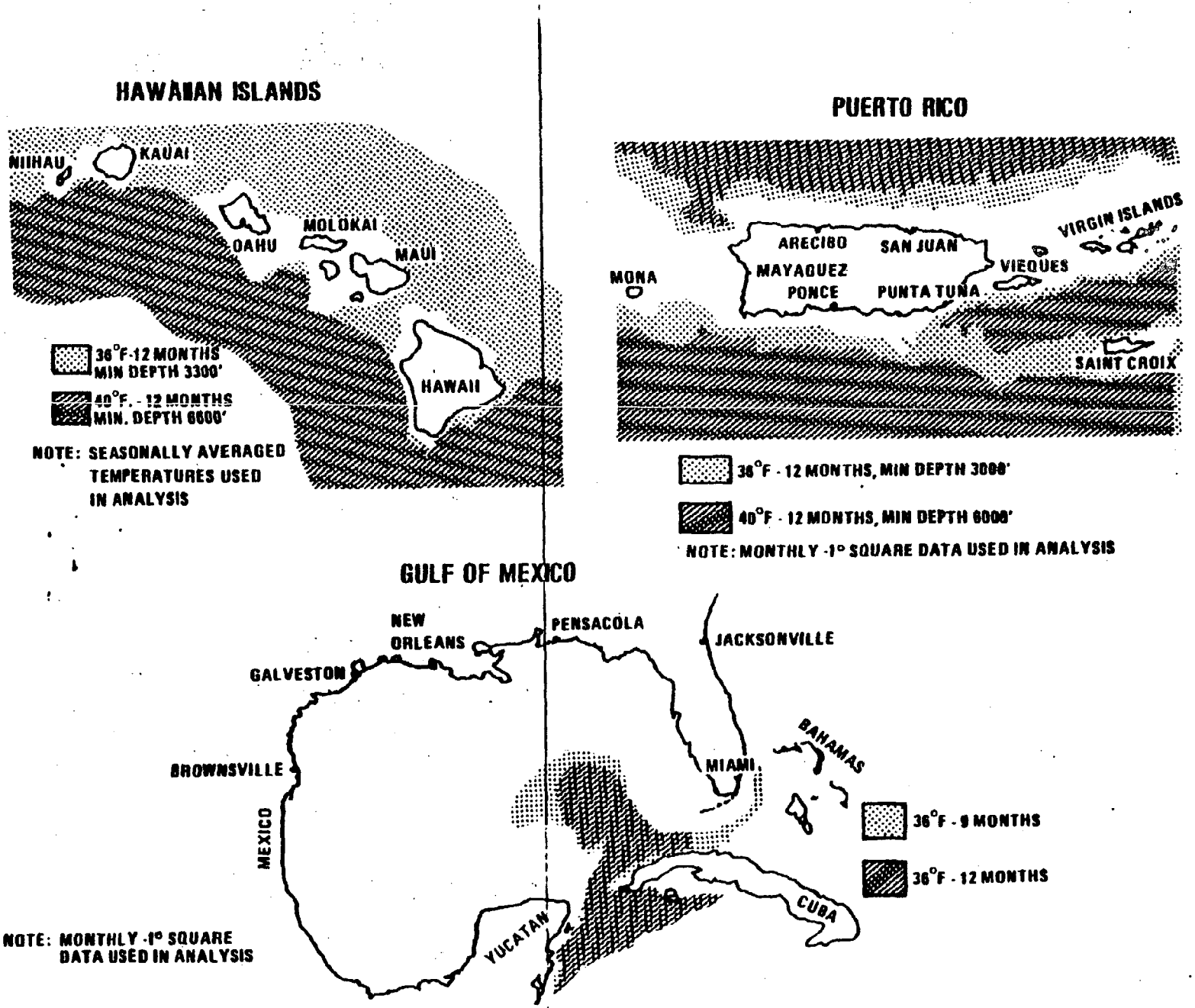

Figure 1.4.2 OTEC Thermal Resource for the U.S. and U.S. Islands.

A number of projections with regard to OTEC commercialization have been made. Congress, in enacting the OTEC Research, Development, and Demonstration Act of 1980 (Public Law 96-310), has established as a national goal demonstration of at least 500 megawatts of OTEC capacity by 1989 and commercial operation of at least 10,000 megawatts of OTEC capacity of 1999. The Council on Environmental Quality has estimated that OTEC could supply 1 to 3 quads (quadrillion British thermal units) of energy by the year 2,000. This is equivalent to 30,000 to 90,000 megawatts of commercial capacity. It has been projected that potential OTEC capacity within 200 miles of the United States coast could be as great as 70 quads per year, or the equivalent of total current U.S. energy consumption. The Hawaiian archipelago alone has been estimated as capable of producing 10-15 quads from OTEC plants.

In the near term, projected commercialization will probably be in the form of small (10-40 megawatt) OTEC electrical plants to supply incremental baseload requirements for U.S. islands in the Pacific and the Carribean. Early development of ammonia production plantships is also expected, with initial sizes in the 40 megawatt electric range capable of 125 metric tons per day of ammonia production. NOAA currently expects two to three licensing applications in these size ranges immediately after licensing regulations are issued in the summer of 1981.

2. AFFECTED ENVIRONMENT

2.1. Open Ocean

As noted earlier, the requisite thermal resource for OTEC development generally exists in a band 20 degrees north and 20 degrees south of the equator. In potential OTEC island areas, elevations rise quickly from great ocean depths. Depths over 1,000 meters occur within 3 kilometers of land at many potential OTEC sites. Bottom sediments range from terrigenous to biogenic in character and may exist as thin layers overlying hard substrate or soft penetrable substrates.

Physical oceanographic parameters of importance to OTEC system design and evaluation of environmental impacts include near-surface current profiles, mixed layer depth and photic zone depth. Circulation patterns are important because warm surface waters are the limiting resource for OTEC operations. While some solar warming of the surface waters at the OTEC location does take place, most of the stored solar energy is obtained in equatorial regions and transported to potential OTEC sites by ocean currents. Figure 2.2.1 shows these large scale circulation patterns. Local and macro scale circulation patterns will control OTEC discharge plume shape and dispersion, thus determining possible discharge plume interferences and transport of OTEC facility and plantship discharges.

The mixed layer is the upper layer of the ocean which is well mixed by wind and wave action. Temperature, salinity, and nutrient concentration values are essentially homogeneous with depth within the mixed layer. The mixed layer defines the vertical extent of the solar resource for OTEC. There is seasonal variation in mixed layer depth with a maximum reached at the onset of winter. Yearly average depth as defined by the depth at which temperature drops to 1° C below sea-surface temperature, in the areas of interest ranges from 22 to 80 meters, with an average of 56 meters.

LARGE SCALE DISTRIBUTION OF

OTEC THERMAL RESOURCE

ΔT(°C) BETWEEN SURFACE AND 1000 METER DEPTHS

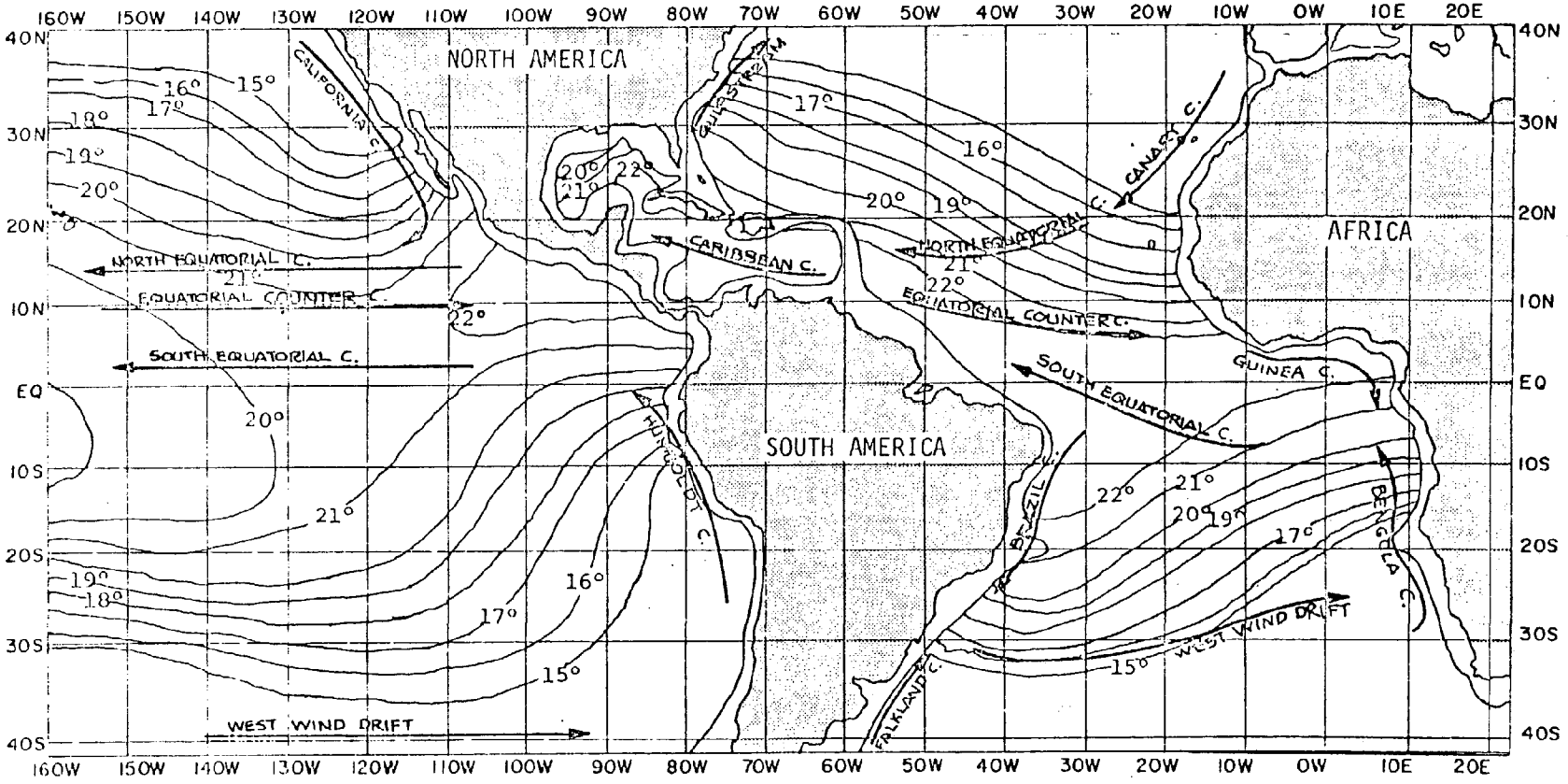

Figure 2.2.1 Large-Scale Circulation Patterns

LARGE SCALE DISTRIBUTION OF

OTEC THERMAL RESOURCE

ΔT(°C) BETWEEN SURFACE AND 1000 METER DEPTH

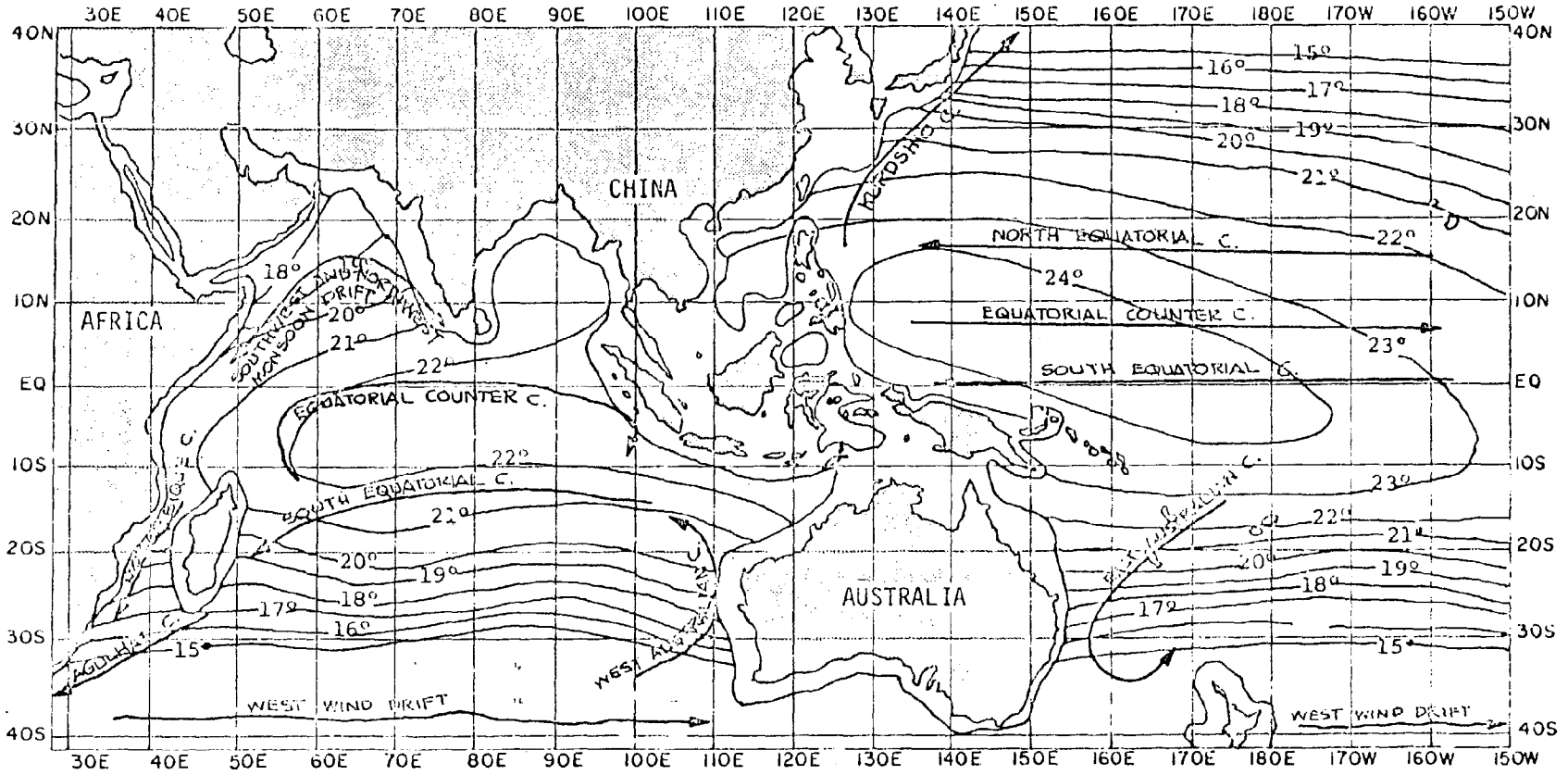

Figure 2.2.1 (Continued)

The photic zone is the surface water layer in which light penetrates to a level of 1 percent of its surface value. Most, if not all, primary biological productivity occurs in the photic zone. The photic zone depth for potential OTEC areas ranges from 120 to 140 meters with a mean value of 125 meters. These values are typical of very clear, blue oceanic waters.

Chemical oceanographic parameters of importance to OTEC environmental assessment include nutrient and dissolved oxygen levels for depths covering potential intakes, discharges, and discharge plume stabilization depths. Carbon dioxide saturation levels both at cold water intake depths and at discharge depths are important for assessing potential carbon dioxide efflux to the atmosphere as a result of OTEC operations.

Nutrient levels, as indicated by nitrate concentration, are very low in surface tropical waters and increase with depth to a maxiumum at 700 to 800 meters. Values at a potential cold water intake depth of 1,000 meters are slightly below the maximum. Ortho-phosphates and silicates display a similar concentration profile with respect to depth.

Dissolved oxygen values are typically a maximum at the sea-surface. The concentration profile with depth shows a decrease to minimum value at approximately 500 meters with an increase to approximately 60 percent of sea-surface values at 1,000 meter cold water intake depths.

Carbon dioxide exists in saturation equilibrium with carbonate, bicarbonate, and carbonic acid in ocean water. Ambient water pressure, temperature, and salinity all govern saturation concentration of carbon dioxide. Decreases in depth, with increases in temperature and salinity all decrease the saturation concentration of carbon dioxide. For this reason, upwelling of the volumes of cold, deep ocean waters associated with commercial OTEC operations have the potential for some release of carbon dioxide to the atmosphere.

Biological considerations of relevance in assessing impacts of OTEC plant operation include all aspects of the ecosystem between the neuston layer at the air-sea interface to the boundary layer between the mesopelagic and bathypelagic zones at depths in excess of 1,000 meters. Phytoplankton are free-floating algae which produce organic matter upon which the marine food chain depends. Phytoplankton production is a photosynthetic process occuring in the photic zone. Measurement of chlorophyll a provides an estimate of phytoplankton biomass. Surface values for chlorophyll a are generally low in tropical and subtropical oceanic waters, but increase with depth to a subsurface maximum at depths of 75 to 150 meters. The actual maximum depth varies both spatially and seasonally. Phytoplankton productivity values in the tropical and subtropical ocean locations for potential OTEC sites are generally low. The exceptions to this are in the equatorial divergence zone, shallow seas, semi-enclosed areas, near land, in areas of natural upwelling, and other places with increased nutrient availability over average ambient values.

Zooplankton, a major component of the next trophic level in the marine food chain, are passively floating or weakly swimming animals of the water column. Zooplankton are concentrated in the upper depths, above approximately 200 to 300 meters. Standing stocks decrease rapidly below those depths, reaching values of 1 percent to 10 percent of surface concentration at depths of 1,000 meters.

Micronekton are actively free-swimming marine organisms in the one to ten centimeter size range which include juveniles of important commercial species. Major micronekton groups include fishes, crustaceans, cephalapods, and gelatinous organisms. Micronekton biomass concentrations exhibit wide variation with area and depth, however a significant amount of data on average values in oceanic areas away from land masses, divergence zones, and upwelling areas is available.

Nekton represents the large free-swimming ocean fishes. Numerous species of commercial and sportfishing importance are found in tropical and subtropical ocean waters, including tuna, dolphinfish, marlin, swordfish, and sailfish. Other nektonic species of lesser commercial importance including squid, sharks, flying fish, sunfish, etc., are found in tropical ocean waters.

Numerous species of marine mammals also occur within potential OTEC resource areas. These include a number of species of porpoise, whales, seals, manatee, and dugong. Sea turtles also occur in the Gulf of Mexico, South Atlantic, Caribbean, Hawaii, and Trust Territories of the Pacific Islands OTEC resource areas.

Deep-sea benthos, the inhabitants of the bottom surface and sediments of the deep ocean are likely to be relatively unaffected by OTEC operations. Characteristics of the benthic community include high-diversity, maintenance of that diversity by mobile scavengers, and the extremely slow metabolic rates of organisms in the deep-sea habitat.

2.2. Atmosphere

Air/sea interactions determine many local and larger scale weather and climatic effects. The relationship between sea-surface temperature, local air temperature and relative humidity governs the occurence of sea fog. Sea-surface temperature variations over large scale areas of the ocean surface govern formation and movement of high-pressure zones. Location and areal extent of high pressure zones govern the movement of tropical ocean storm tracks. There is evidence that natural occurence of sea-surface temperature anomalies over large areas of the Pacific ocean have resulted in inshore movement of storm tracks along the coasts of California and Oregon.

Carbon dioxide concentrations in surface waters govern interchange of carbon dioxide between the atmosphere and ocean waters.

2.3. Coastal Areas

Coastal features in potential OTEC application areas include habitat for large numbers of seabirds, breeding area for sea turtles, and habitat for the young of many commercially and recreationally important species of finfish and shellfish. Significant features include coral reefs and tropical islands of the western Atlantic, western Pacific and Caribbean, as well as wetlands, bayous, and barrier islands along the Gulf of Mexico coast of the United States. Habitat for sea turtles is found throughout Hawaii and the Trust Territories of the Pacific Islands as well as in the Gulf of Mexico, western Atlantic, and the Caribbean. Numerous species of crocodile and alligator are found in south Florida, along the Gulf Coast, and in the Caribbean Islands. Much of the United States Gulf Coast is an important breeding area for commercially important shrimp and shellfish fisheries.

Numerous populations of coastal and island associated seabirds such as pelicans, gulls, and booby frequent potential coastal OTEC application areas. Large populations of transitory migrants such as the golden plover are also found.

3. ENVIRONMENTAL CONSEQUENCES

A closed cycle OTEC plant will require some 6 million gallons of warm water flow per minute, and an equivalent flow of cold water, for each 100 MW of net power generated. This 12 million gallons per minute of total flow must be reintroduced into the water column either separately, through individual warm and cold water discharges, or as a mixed discharge. In addition to potentially being of different temperature and salinity than ambient waters at the point of discharge, these flows can have different chemical and biological properties that are characteristic of ocean water at the intake locations. In considering the relatively large ocean water flow rates, the physical presence of the facilities, and the trace and other constituents which may be released, environmental concerns arise as discussed in the following sections.

3.1. Direct Open Ocean Consequences

3.1.1. Displacement of Ocean Water Mass

The displacement of large quantities of ocean water causes artificial disturbance of natural thermal and salinity profiles (thus density), as well as levels of dissolved gases, nutrients, carbonates and turbidity. The behavior of the OTEC discharge plume, both in the near-field and far-field, must be predicted in order to assess the resulting impacts.

The near-field refers to that region of the discharge plume within which the behavior is governed primarily by the discharge geometry, its initial momentum, and the density of the ambient water. This region is characterized by time scales generally less than 1,000 seconds and spatial scales of less than approximately 1,000 meters. This is the period when the dilution of the discharge with ambient seawater takes place most quickly (initial dilution), being due to the turbulent motion of the discharge that quickly entrains ambient water. It is also the phase of dilution over which the design engineer has the most

control, with key design parameters including the geometry, velocity, and depth of the discharge.

In contrast to the near-field region, the far-field refers to that region where natural oceanic currents, turbulence, and planetary rotation both move and disperse the discharge plume. Subsequent dilution, that dilution of the discharge plume that occurs during this period, is very much slower than initial dilution. As a consequence, far-field processes are characterized by time and spatial scales greater than those above that define the near-field. During the early stages of far-field processes, gravitational spreading of the discharge can also occur.

The near-field fate of the discharge plume is totally dependent upon geometry of the discharge (primarily the orifice size and angle of the discharge), the depth of the discharge, and the density of the discharge relative to the density structure of the water column. If the density of the discharge is less than that of the immediate ambient environment, the density difference will impart a positive buoyancy force and the discharge will rise until it reaches the surface itself or a point of neutral buoyancy beneath the surface. Neutral buoyancy is usually achieved when there is a thermocline present above the discharge location; in this situation, the plume stratifies and spreads at this level much as smog stratifies and spreads beneath an atmospheric inversion layer.

If the discharge is heavier than the immediate ambient water, the discharge will sink. This situation can be visualized as the reverse of the above situation, and the plume will either stratify at a thermocline, reach (theoretically) the bottom, or become so dilute that it is non-detectable.

Currently, popular OTEC designs involve a mixed discharge that will have properties intermediate between those of the surface (warm intake) waters and

deeper (cold intake) waters. Such a discharge will stratify near the thermocline, rising to it if the discharge depth is below the thermocline or sinking to it if the discharge depth is above the thermocline. The exact trajectory and resulting dilution will be dependent upon factors mentioned above. Predictions have been performed for OTEC plants in the range of 40-400 MWe that were discharging a mixed effluent horizontally through pipes in the size range of 14 to 21 meters. With the discharge at a depth of about 50 meters and the top of thermocline being located at about 100 meters, the discharge sank to the thermocline, at which point initial dilutions on the order of 3 were achieved. Dilutions are typically defined as the ratio of the volume of the discharge plus entrained ambient water to the volume of the discharge. For example, a dilution of 3 connotes that 1 unit volume of the discharge has mixed with 2 unit volumes of ambient seawater.

3.1.2. Heat balance alteration

In all likelihood, a single OTEC plant in a given region or water mass will not impact the overall heat balance of that water mass to a degree that would give rise to concern. However, there is a need to assess the overall heat balance effects of multiple plants. Siince energy in the form of heat is being extracted from the water mass to produce work, it would be expected that the thermal resource can be considered renewable only up to some finite number of plants.

Calculations on the Gulf of Mexico have indicated that 100 OTEC plants, each of 200 MWe capacity, operating in the Gulf for 30 years would reduce the sea-surface temperature by about 0.05°C and warm the deeper ocean waters above the cold water intake (500-1,000 meters) by about 0.08°C. Although more analysis of this problem needs to be performed these depressions are considered small compared to the persistent natural anomalies that are known to affect ocean dynamics and, at a minimum, regional climates.

3.1.3. Release of carbon dioxide

Any effects of ocean thermal energy conversion on the CO_2 balance between the oceans and atmosphere are of concern because of the role of CO_2 in long-term weather changes. The CO_2 molecule serves a unique role regarding the heat balance of the Earth, having little effect on short-wavelength solar radiation reaching the Earth yet absorbing longer wavelength radiation reemitted by the Earth. This is the basis of the concern referred to as the "greenhouse" effect when higher atmospheric CO_2 levels would result in a warming of global temperatures due to increased absorption of the longer wavelength radiation. It is a major concern regarding continued use of fossil fuels.

Atmospheric CO_2 exists in equilibrium with dissolved CO_2 in the oceans and other aquatic systems. Within the ocean and other waters, carbon dioxide exists in equilibrium with the carbonate system which is composed of carbonic acid (H_2CO_3), bicarbonate (HCO_3^-), and carbonate ($CO_3^{=}$).

The saturation concentration of CO_2 is greater in the deeper, colder waters of the ocean, than in the surface waters. Thus, the operation of an OTEC plant will bring large volumes of CO_2-rich water to the surface where it may have a potential effect. The amount of CO_2 efflux from a 400-MW OTEC configuration has been estimated to be about one-fourth of that which would be released from a coal-fired plant of equivalent capacity. Although there is some concern that the release could have potential regional effects, large-scale climate effects are not anticipated.

3.1.4. Nutrient redistribution

Nutrient redistribution will occur as a result of OTEC discharge. Upwelling of large amounts of cold, nutrient rich water may increase primary productivity as has been demonstrated in aquaculture experiments in the Virgin Islands and off the coast of California. This is particularly true if the discharge

plume remains above the 10 percent light penetration level, below which sunlight availability is the limiting factor on productivity. Simplified modeling of primary productivity effects of a 400 MWe OTEC plant discharge based on this assumption showed phytoplankton biomass to be 30 times ambient within the plume 30 to 60 kilometers downstream (3 to 6 days) of the discharge. Thus significantly increased phytoplankton levels may be maintained downstream of commercial OTEC facilities. However, this tendency may be countered by inhibitory effects of the biocide chosen for controlling fouling of the OTEC plant heat exchangers.

3.1.5. Entrainment and impingement of marine organisms

Impingement of marine organisms occurs on the intake screens for cold and warm ocean waters. Organisms which pass through the intake screens are entrained in the water flow and pass through the OTEC plant seawater system, including piping, heat exchangers, and pumps. It has been estimated that a 400 MWe OTEC plant will impinge a total of about 2,000 kilograms of biomass each day, consisting of micronekton and gelatinous biomass. It is further estimated that the ecological impact of this loss, at least for a single plant, will be insignificant due to the replacement capability of the surrounding micronekton population and the mobility of the nektonic organisms which prey on micronekton.

Organisms entrained in the warm water intake of an OTEC plant are subject to physical abuse and biocides as they pass through the plant. Organisms similarly entrained in the cold water intake flow will also be subject to a temperature change of 20 degrees C and a 100 atmosphere decompression. Current designs for OTEC inlet screens and heat exchangers will likely result in entrainment of organisms less than 4 centimeters in size.

Overall entrainment rates for a 400 MWe OTEC plant are projected to be approximately 2,000 kilograms per day, including phytoplankton and zooplankton. Most of this will occur at the warm water intake as phytoplankton and microzooplankton concentration at 1,000 meter depths is comparatively low.

3.1.6. Biofouling prevention

OTEC plant efficiency is highly dependent on maintaining clean heat exchanger surfaces. Buildup of a 50-micrometer thick layer of slime on heat exchanger surfaces would reduce plant efficiency by 15 to 25 percent. In essence, a fouling buildup visible to the naked eye is unacceptable. Both mechanical and chemical methods to prevent this buildup are contemplated.

Mechanical methods include introduction into the seawater system and recovery of rubber balls with abrasive coatings and use of mechanical brush scrubbers. The effect on biota of these devices is similar to entrainment and impingement effects.

Chemical methods for biofouling control include continuous or periodic introduction of chlorine, chlorine dioxide, bromine or ozone into seawater piping, heat exchangers, and pumps. Chlorine is the most widely used chemical for biofouling control and it can be produced directly from seawater. Current Environmental Protection Agency guidelines limit chlorine levels in cooling water discharges to approximately 0.1 or 0.2 milligrams per liter. Under this type of constraint, 3,700 kilograms per day of chlorine could be discharged into surface seawater layers by a 400 MWe OTEC plant. Modeling efforts show a chlorine concentration at the centerline of the discharge plume from a 400 MWe plant of 0.03 mg./liter after 100 kilometers of downstream travel. However, considerable uncertainty exists as to the actual chemistry of this residual in seawater.

3.1.7. Working fluid leaks.

The most likely OTEC working fluid is ammonia (NH_3). It is estimated that the onboard inventory of ammonia for a 400 MWe OTEC electricity generating plant would be about 10,000 cubic meters, or 2,460,000 gallons. If a large sea-surface ammonia spill should occur, 40 percent would be released to the atmosphere and 60 percent would dissolve in surface ocean waters. The dissolved

ammonia would form ammonium hydroxide, which will then dissociate into ammonium and hydroxyl ions with a resulting increase in ambient pH value. Limited toxicity data indicate inhibited photosynthesis in marine phytoplankton at ammonia concentrations of 50 to 70 milligrams per liter of seawater.

3.1.8. Corrosion and erosion of metal surfaces.

OTEC plants are expected to require approximately 10 thousand square meters of seawater heat exchanger surface for each megawatt of electrical capacity. Thus a 400 MWe OTEC plant will need a total heat exchanger area of about 4 million square meters. Potential heat exchanger materials include aluminum, titanium, copper-nickel alloys, and stainless steel.

Available data indicate the toxicity of aluminum and titanium to marine organisms is very low. However, copper has been shown to inhibit marine dinoflagellate productivity at concentrations above 1,000 milligrams per liter. Exposure to 20 milligrams per liter for more than twenty hours has reduced growth rates.

To produce a discharge concentration of 1 milligram per liter would require daily loss of approximately 60 grams per square meter of heat exchanger surface. Estimates are that actual release rates will be several orders of magnitude less than this and no impact is expected.

3.1.9. Artificial reef effects

Finfish and shellfish often congregate around offshore structures and thus OTEC platforms are expected to attract and provide habitat for large numbers of organisms. Estimates of actual population numbers and species diversity must be made on a site-specific and platform-specific basis.

Platform siting in relation to other uses of the outer continental shelf and the high seas may increase the likelihood of collisions between vessels and the platform. This issue must also be addressed on a site-specific basis.

3.1.10. Crew support system discharges

Manned OTEC platforms and plantships will discharge laundry and galley wastes as well as treated sanitary wastes. Estimating a crew size of 25 persons and a 200 gallons per day waste water load per person, the resulting discharge of sewage, galley wastes, etc., would be 5,000 gallons per day. U.S. Coast Guard and Environmental Protection Agency regulations apply and all discharges would be treated in accordance with them. Since rapid mixing and dilution will occur after discharge, the environmental consequences are expected to be negligible.

3.1.11. Transfer of products and supplies

Crew members, supplies and provisions must be transfered to and from OTEC electricity production facilities. Raw materials and manufactured products must be moved to and from OTEC industrial facilities and plantships. These activities will be subject to United States and international standards for safety and pollution prevention. Potential accidental release rates will be estimated from historical marine transportation data. Additional regulatory controls may be necessary.

3.2. Direct Coastal Consequences

3.2.1. OTEC fabrication and deployment

Fabrication of OTEC facilities will involve increased activity at coastal shipyards and construction facilities with attendant increased demand for housing and community services. Construction of onshore OTEC facilities will involve site clearing, excavation, and grading as well as facility construction. Deployment of floating OTEC facilities and cold water pipe may require construction of temporary staging sites in coastal locations close to deployment sites for final assembly of platform components and cold water pipe. This activity is analoguous to onshore activities associated with outer continental shelf oil development. However, OTEC development will not proceed at the historical pace of OCS activities and associated coastal impacts could be significantly less.

3.2.2. Electrical transmission cables

Transmission of electrical power from an offshore OTEC facility to the onshore distribution grid will require use of submarine cables. These cables will be buried beneath the seafloor for protection from fouling and breakage due to other marine activities such as trawling and anchoring. The transition from the seafloor cable to the OTEC facility will require a riser cable capable of withstanding stresses of currents, waves, and OTEC platform motions. Navigation aids and chart markings will be required to minimize interference. Interrupting devices will be required to stop electrical current flow in the event of cable breakage.

Emplacement of submarine cables will produce environmental impacts similar to those associated with pipeline emplacement. Local benthic scouring and turbidity will occur along the cable route. Some surface turbidity will result

from trenching activities. These impacts are expected to be of short duration and will be assessed in detail during evaluation of license applications.

3.2.3. Onshore electrical facilities

Electrical cable landfalls will be required for OTEC facilities moored to or standing on the seabed. Placement of the landfall will involve temporary disruption of habitat in the intertidal and foreshore zones. The transition from submarine cable to onshore transmission line may require construction of a substation facility. Finally, if the OTEC facility is located more than 10 or 15 kilometers offshore, a facility for converting direct current to alternating current for further distribution to the shoreside electrical grid may be necessary. Direct current will be used for greater at-sea transmission distances due to lower cable losses associated with direct current transmission.

3.2.4. Product pipelines

If ammonia or other liquid or gaseous product is produced aboard an offshore OTEC facility, it may be moved to shoreside markets by subsea pipeline. Impacts of pipeline emplacement and operation will be similar to those associated with current seabed pipeline technology, including temporary effects of pipeline emplacement and impacts associated with operation, such as leaks and pipeline breakage. As with electrical transmission cables, a detailed assessment of submarine product pipeline impacts will be conducted during review of specific license applications.

3.2.5. Product processing facilities

If energy intensive products such as aluminum are manufactured aboard OTEC plantships, onshore processing facilities may also be required. For example, an aluminum producing OTEC facility might require an onshore ore processing mill to extract alumina from bauxite. If such a situation arises, it will be dealt with in the license-specific environmental impact statement.

3.3. Cumulative, indirect, and long-term effects

3.3.1. Energy supply and demand

Cumulative incremental electricity demand for United States island states, commonwealths, and territories is expected to increase by 5,000 megawatts by the year 2000. OTEC is a renewable, non-consumptive energy technology. Each megawatt of electricity production diverted from oil based to OTEC based on an annual basis yields a saving of 40 barrels per day of oil consumption. Thus if all incremental island demand were met by means of OTEC, an annual savings of approximately 73 million barrels of oil would result. Assuming most of this to be imported oil, an annual decrease in cost of oil imports of over $2 billion would accrue, based on 1980 prices (in 1980 dollars).

As noted earlier, if post 1985 fertilizer demand increases were met by OTEC ammonia production, an annual savings of 12 billion cubic feet of natural gas would be realized for diversion to domestic and other industrial uses.

3.3.2. Global environmental effects

Carbon dioxide efflux to the atmosphere is a potential global effect of widespread OTEC development. Carbon dioxide concentration in the atmosphere is increasing. This increases the "greenhouse" effect of the Earth's atmosphere and is postulated to result in an overall warming trend on the planet.

Assuming that all excess carbon dioxide above sea-surface saturation levels is emitted to the atmosphere yields an estimate of about 2 million kilograms per day of carbon dioxide release from a 400 MWe OTEC plant. This is likely to be an over-estimate as some of the carbon dioxide in upwelled waters may be taken up during increased surface water biological activity before it is released to the atmosphere.

For comparison purposes, a 400 MWe coal fired powerplant would release about 8.6 million kilograms per day of carbon dioxide to the atmosphere, or over four times the maximum level projected for an equivalent OTEC plant.

Public Law 96-320
96th Congress

An Act

Aug. 3, 1980
[S. 2492]

To regulate commerce, promote energy self-sufficiency, and protect the environment, by establishing procedures for the location, construction, and operation of ocean thermal energy conversion facilities and plantships to produce electricity and energy-intensive products off the coasts of the United States; to amend the Merchant Marine Act, 1936, to make available certain financial assistance for construction and operation of such facilities and plantships; and for other purposes.

Ocean Thermal Energy Conversion Act of 1980.
42 USC 9101 note.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Ocean Thermal Energy Conversion Act of 1980".

42 USC 9101.

SEC. 2. DECLARATION OF POLICY.

(a) It is declared to be the purposes of the Congress in this Act to—

(1) authorize and regulate the construction, location, ownership, and operation of ocean thermal energy conversion facilities connected to the United States by pipeline or cable, or located in the territorial sea of the United States consistent with the Convention on the High Seas, and general principles of international law;

(2) authorize and regulate the construction, location, ownership, and operation of ocean thermal energy conversion plantships documented under the laws of the United States, consistent with the Convention on the High Seas and general principles of international law;

(3) authorize and regulate the construction, location, ownership, and operation of ocean thermal energy conversion plantships by United States citizens, consistent with the Convention on the High Seas and general principles of international law;

(4) establish a legal regime which will permit and encourage the development of ocean thermal energy conversion as a commercial energy technology;

(5) provide for the protection of the marine and coastal environment, and consideration of the interests of ocean users, to prevent or minimize any adverse impact which might occur as a consequence of the development of such ocean thermal energy conversion facilities or plantships;

(6) make applicable certain provisions of the Merchant Marine Act, 1936 (46 U.S.C. 1177 et seq.) to assist in financing of ocean thermal energy conversion facilities and plantships;

(7) protect the interests of the United States in the location, construction, and operation of ocean thermal energy conversion facilities and plantships; and

(8) protect the rights and responsibilities of adjacent coastal States in ensuring that Federal actions are consistent with approved State coastal zone management programs and other applicable State and local laws.

(b) The Congress declares that nothing in this Act shall be construed to affect the legal status of the high seas, the superjacent airspace, or the seabed and subsoil, including the Continental Shelf.

SEC. 3. DEFINITIONS. 42 USC 9102.

As used in this Act, unless the context otherwise requires, the term—

(1) "adjacent coastal State" means any coastal State which is required to be designated as such by section 105(a)(1) of this Act or is designated as such by the Administrator in accordance with section 105(a)(2) of this Act;

(2) "Administrator" means the Administrator of the National Oceanic and Atmospheric Administration;

(3) "antitrust laws" includes the Act of July 2, 1890, as amended, the Act of October 15, 1914, as amended, and sections 73 and 74 of the Act of August 27, 1894, as amended; 15 USC 1, 12, 8, 9.

(4) "application" means any application submitted under this Act (A) for issuance of a license for the ownership, construction, and operation of an ocean thermal energy conversion facility or plantship; (B) for transfer or renewal of any such license; or (C) for any substantial change in any of the conditions and provisions of any such license;

(5) "coastal State" means a State in, or bordering on, the Atlantic, Pacific, or Arctic Ocean, the Gulf of Mexico, Long Island Sound, or one or more of the Great Lakes;

(6) "construction" means any activities conducted at sea to supervise, inspect, actually build, or perform other functions incidental to the building, repairing, or expanding of an ocean thermal energy conversion facility or plantship or any of its components, including but not limited to, piledriving, emplacement of mooring devices, emplacement of cables and pipelines, and deployment of the cold water pipe, and alterations, modifications, or additions to an ocean thermal energy conversion facility or plantship;

(7) "facility" means an ocean thermal energy conversion facility;

(8) "Governor" means the Governor of a State or the person designated by law to exercise the powers granted to the Governor pursuant to this Act;

(9) "high seas" means that part of the oceans lying seaward of the territorial sea of the United States and outside the territorial sea, as recognized by the United States, of any other nation;

(10) "licensee" means the holder of a valid license for the ownership, construction, and operation of an ocean thermal energy conversion facility or plantship that was issued, transferred, or renewed pursuant to this Act;

(11) "ocean thermal energy conversion facility" means any facility which is standing or moored in or beyond the territorial sea of the United States and which is designed to use temperature differences in ocean water to produce electricity or another form of energy capable of being used directly to perform work, and includes any equipment installed on such facility to use such electricity or other form of energy to produce, process, refine, or manufacture a product, and any cable or pipeline used to deliver such electricity, freshwater, or product to shore, and all other associated equipment and appurtenances of such facility, to the extent they are located seaward of the highwater mark;

(12) "ocean thermal energy conversion plantship" means any vessel which is designed to use temperature differences in ocean water while floating unmoored or moving through such water, to produce electricity or another form of energy capable of being used directly to perform work, and includes any equipment

installed on such vessel to use such electricity or other form of energy to produce, process, refine, or manufacture a product, and any equipment used to transfer such product to other vessels for transportation to users, and all other associated equipment and appurtenances of such vessel;

(13) "plantship" means an ocean thermal energy conversion plantship;

(14) "person" means any individual (whether or not a citizen of the United States), any corporation, partnership, association, or other entity organized or existing under the laws of any nation, and any Federal, State, local or foreign government or any entity of any such government;

(15) "State" means each of the several States, the District of Columbia, the Commonwealth of Puerto Rico, American Samoa, the United States Virgin Islands, Guam, the Commonwealth of the Northern Marianas, and any other Commonwealth, territory, or possession over which the United States has jurisdiction;

(16) "test platform" means any floating or moored platform, barge, ship, or other vessel which is designed for limited-scale, at sea operation in order to test or evaluate the operation of components or all of an ocean thermal energy conversion system and which will not operate as an ocean thermal energy conversion facility or plantship after the conclusion of such tests or evaluation;

(17) "thermal plume" means the area of the ocean in which a significant difference in temperature, as defined in regulations by the Administrator, occurs as a result of the operation of an ocean thermal energy conversion facility or plantship; and

(18) "United States citizen" means (A) any individual who is a citizen of the United States by law, birth, or naturalization; (B) any Federal, State, or local government in the United States, or any entity of any such government; or (C) any corporation, partnership, association, or other entity, organized or existing under the laws of the United States, or of any State, which has as its president or other executive officer and as its chairman of the board of directors, or holder of similar office, an individual who is a United States citizen and which has no more of its directors who are not United States citizens than constitute a minority of the number required for a quorum necessary to conduct the business of the board.

TITLE I—REGULATION OF OCEAN THERMAL ENERGY CONVERSION FACILITIES AND PLANTSHIPS

42 USC 9111.

SEC. 101. LICENSE FOR THE OWNERSHIP, CONSTRUCTION, AND OPERATION OF AN OCEAN THERMAL ENERGY CONVERSION FACILITY OR PLANTSHIP.

(a) No person may engage in the ownership, construction, or operation of an ocean thermal energy conversion facility which is documented under the laws of the United States, which is located in the territorial sea of the United States, or which is connected to the United States by pipeline or cable, except in accordance with a license issued pursuant to this Act. No citizen of the United States may engage in the ownership, construction or operation of an ocean thermal energy conversion plantship except in accordance with a license issued pursuant to this Act, or in accordance with a license issued by a foreign nation whose licenses are found by the Adminis-

trator, after consultation with the Secretary of State, to be compatible with licenses issued pursuant to this Act.

(b) The Administrator shall, upon application and in accordance with the provisions of this Act, issue, transfer, amend, or renew licenses for the ownership, construction, and operation of—

(1) ocean thermal energy conversion plantships documented under the laws of the United States, and

(2) ocean thermal energy conversion facilities documented under the laws of the United States, located in the territorial sea of the United States, or connected to the United States by pipeline or cable.

License issuance, prerequisites.

(c) The Administrator may issue a license to a citizen of the United States in accordance with the provisions of this Act unless—

(1) he determines that the applicant cannot and will not comply with applicable laws, regulations, and license conditions;

(2) he determines that the construction and operation of the ocean thermal energy conversion facility or plantship will not be in the national interest and consistent with national security and other national policy goals and objectives, including energy self-sufficiency and environmental quality;

(3) he determines, after consultation with the Secretary of the department in which the Coast Guard is operating, that the ocean thermal energy conversion facility or plantship will not be operated with reasonable regard to the freedom of navigation or other reasonable uses of the high seas and authorized uses of the Continental Shelf, as defined by United States law, treaty, convention, or customary international law;

(4) he has been informed, within 45 days after the conclusion of public hearings on that application, or on proposed licenses for the designated application area, by the Administrator of the Environmental Protection Agency that the ocean thermal energy conversion facility or plantship will not conform with all applicable provisions of any law for which he has enforcement authority;

(5) he has received the opinion of the Attorney General, pursuant to section 104 of this Act, stating that issuance of the license would create a situation in violation of the antitrust laws, or the 90-day period provided in section 104 has expired;

(6) he has consulted with the Secretary of Energy, the Secretary of Transportation, the Secretary of State, the Secretary of the Interior, and the Secretary of Defense, to determine their views on the adequacy of the application, and its effect on programs within their respective jurisdictions and determines on the basis thereof, that the application for license is inadequate;

(7) the proposed ocean thermal energy conversion facility or plantship will not be documented under the laws of the United States;

(8) the applicant has not agreed to the condition that no vessel may be used for the transportation to the United States of things produced, processed, refined, or manufactured at the ocean thermal energy conversion facility or plantship unless such vessel is documented under the laws of the United States;

(9) when the license is for an ocean thermal energy conversion facility, he determines that the facility, including any submarine electric transmission cables and equipment or pipelines which are components of the facility, will not be located and designed so as to minimize interference with other uses of the high seas or

the Continental Shelf, including cables or pipelines already in position on or in the seabed and the possibility of their repair;

(10) the Governor of each adjacent coastal State with an approved coastal zone management program in good standing pursuant to the Coastal Zone Management Act of 1972 (33 U.S.C. 1451 et seq.) determines that, in his or her view, the application is inadequate or inconsistent with respect to programs within his or her jurisdiction;

16 USC 1451 *et seq.*

(11) when the license is for an ocean thermal energy conversion facility, he determines that the thermal plume of the facility is expected to impinge on so as to degrade the thermal gradient used by any other ocean thermal energy conversion facility already licensed or operating, without the consent of its owner;

(12) when the license is for an ocean thermal energy conversion facility, he determines that the thermal plume of the facility is expected to impinge on so as to adversely affect the territorial sea or area of national resource jurisdiction, as recognized by the United States, of any other nation, unless the Secretary of State approves such impingement after consultation with such nation;

(13) when the license is for an ocean thermal energy conversion plantship, he determines that the applicant has not provided adequate assurance that the plantship will be operated in such a way as to prevent its thermal plume from impinging on so as to degrade the thermal gradient used by any other ocean thermal energy conversion facility or plantship without the consent of its owner, and from impinging on so as to adversely affect the territorial sea or area of national resource jurisdiction, as recognized by the United States, of any other nation unless the Secretary of State approves such impingement after consultation with such nation; and

(14) when a regulation has been adopted which places an upper limit on the number or total capacity of ocean thermal energy conversion facilities or plantships to be licensed under this Act for simultaneous operation, either overall or within specific geographic areas, pursuant to a determination under the provisions of section 107(b)(4) of this Act, issuance of the license will cause such upper limit to be exceeded.

Issuance conditions.

(d)(1) In issuing a license for the ownership, construction, and operation of an ocean thermal energy conversion facility or plantship, the Administrator shall prescribe conditions which he deems necessary to carry out the provisions of this Act, or which are otherwise required by any Federal department or agency pursuant to the terms of this Act.

Written agreement of compliance.

(2) No license shall be issued, transferred, or renewed under this Act unless the licensee or transferee first agrees in writing that (A) there will be no substantial change from the plans, operational systems, and methods, procedures, and safeguards set forth in his application, as approved, without prior approval in writing from the Administrator, and (B) he will comply with conditions the Administrator may prescribe in accordance with the provisions of this Act.

Disposal or removal requirements.

(3) The Administrator shall establish such bonding requirements or other assurances as he deems necessary to assure that, upon the revocation, termination, relinquishment, or surrender of a license, the licensee will dispose of or remove all components of the ocean thermal energy conversion facility or plantship as directed by the Administrator. In the case of components which another applicant or licensee desires to use, the Administrator may waive the disposal or removal requirements until he has reached a decision on the applica-

Waiver.

tion. In the case of components lying on or below the seabed, the Administrator may waive the disposal or removal requirements if he finds that such removal is not otherwise necessary and that the remaining components do not constitute any threat to the environment, navigation, fishing, or other uses of the seabed.

License transfer.

(e) Upon application, a license issued under this Act may be transferred if the Administrator determines that such transfer is in the public interest and that the transferee meets the requirements of this Act and the prerequisites to issuance under subsection (c) of this section.

(f) Any United States citizen who otherwise qualifies under the terms of this Act shall be eligible to be issued a license for the ownership, construction, and operation of an ocean thermal energy conversion facility or plantship.

License term and renewal.

(g) Licenses issued under this Act shall be for a term of not to exceed 25 years. Each licensee shall have a preferential right to renew his license subject to the requirements of subsection (c) of this section, upon such conditions and for such term, not to exceed an additional 10 years upon each renewal, as the Administrator determines to be reasonable and appropriate.

SEC. 102. PROCEDURE.

42 USC. 9112.

Regulations.

(a) The Administrator shall, after consultation with the Secretary of Energy and the heads of other Federal agencies, issue regulations to carry out the purposes and provisions of this Act, in accordance with the provisions of section 553 of title 5, United States Code, without regard to subsection (a) thereof. Such regulations shall pertain to, but need not be limited to, application for issuance, transfer, renewal, suspension, and termination of licenses. Such regulations shall provide for full consultation and cooperation with all other interested Federal agencies and departments and with any potentially affected coastal State, and for consideration of the views of any interested members of the general public. The Administrator is further authorized, consistent with the purposes and provisions of this Act, to amend or rescind any such regulation. The Administrator shall complete issuance of final regulations to implement this Act within 1 year of the date of its enactment.

Consultation.

(b) The Administrator, in consultation with the Secretary of the Interior and the Secretary of the department in which the Coast Guard is operating may, if he determines it to be necessary, prescribe regulations consistent with the purposes of this Act, relating to those activities in site evaluation and preconstruction testing at potential ocean thermal energy conversion facility or plantship locations that may (1) adversely affect the environment; (2) interfere with other reasonable uses of the high seas or with authorized uses of the Outer Continental Shelf; or (3) pose a threat to human health and safety. If the Administrator prescribes regulations relating to such activities, such activities may not be undertaken after the effective date of such regulations except in accordance therewith.

Expertise or statutory responsibility descriptions.

(c) Not later than 60 days after the date of enactment of this Act, the Secretary of Energy, the Administrator of the Environmental Protection Agency, the Secretary of the department in which the Coast Guard is operating, the Secretary of the Interior, the Chief of Engineers of the United States Army Corps of Engineers, and the heads of any other Federal departments or agencies having expertise concerning, or jurisdiction over, any aspect of the construction or operation of ocean thermal energy conversion facilities or plantships, shall transmit to the Administrator written description of their

expertise or statutory responsibilities pursuant to this Act or any other Federal law.

Application receipt and notice.

Publication in Federal Register.

(d)(1) Within 21 days after the receipt of an application, the Administrator shall determine whether the application appears to contain all of the information required by paragraph (2) of this subsection. If the Administrator determines that such information appears to be contained in the application, the Administrator shall, no later than 5 days after making such a determination, publish notice of the application and a summary of the plans in the Federal Register. If the Administrator determines that all of the required information does not appear to be contained in the application, the Administrator shall notify the applicant and take no further action with respect to the application until such deficiencies have been remedied.

(2) Each application shall include such financial, technical, and other information as the Administrator determines by regulation to be necessary or appropriate to process the license pursuant to section 101.

Area description, publication in Federal Register.

(e)(1) At the time notice of an application for an ocean thermal energy conversion facility is published pursuant to subsection (d) of this section, the Administrator shall publish a description in the Federal Register of an application area encompassing the site proposed in the application for such facility and within which the thermal plume of one ocean thermal energy conversion facility might be expected to impinge on so as to degrade the thermal gradient used by another ocean thermal energy conversion facility, unless the application is for a license for an ocean thermal energy conversion facility to be located within an application area which has already been designated.

Additional license applications.

(2) The Administrator shall accompany such publication with a call for submission of any other applications for licenses for the ownership, construction, and operation of an ocean thermal energy conversion facility within the designated application area. Any person intending to file such an application shall submit a notice of intent to file an application to the Administrator not later than 60 days after the publication of notice pursuant to subsection (d) of this section, and shall submit the completed application no later than 90 days after publication of such notice. The Administrator shall publish notice of any such application received in accordance with subsection (d) of this section. No application for a license for the ownership, construction, and operation of an ocean thermal energy conversion facility within the designated application area for which a notice of intent to file was received after such 60-day period, or which is received after such 90-day period has elapsed, shall be considered until action has been completed on all timely filed applications pending with respect to such application area.

(f) An application filed with the Administrator shall constitute an application for all Federal authorizations required for ownership, construction, and operation of an ocean thermal energy conversion facility or plantship, except for authorizations required by documentation, inspection, certification, construction, and manning laws and regulations administered by the Secretary of the department in which the Coast Guard is operating. At the time notice of any application is published pursuant to subsection (d) of this section, the Administrator shall forward a copy of such application to those Federal agencies and departments with jurisdiction over any aspect of such ownership, construction, or operation for comment, review, or recommendation as to conditions and for such other action as may be

Application copies.

required by law. Each agency or department involved shall review the application and, based upon legal considerations within its area of responsibility, recommend to the Administrator the approval or disapproval of the application not later than 45 days after public hearings are concluded pursuant to subsection (g) of this section. In any case in which an agency or department recommends disapproval, it shall set forth in detail the manner in which the application does not comply with any law or regulation within its area of responsibility and shall notify the Administrator of the manner in which the application may be amended or the license conditioned so as to bring it into compliance with the law or regulation involved.

Application review.

(g) A license may be issued, transferred, or renewed only after public notice, opportunity for comment, and public hearings in accordance with this subsection. At least one such public hearing shall be held in the District of Columbia and in any adjacent coastal State to which a facility is proposed to be directly connected by pipeline or electric transmission cable. Any interested person may present relevant material at any such hearing. After the hearings required by this subsection are concluded, if the Administrator determines that there exist one or more specific and material factual issues which may be resolved by a formal evidentiary hearing, at least one adjudicatory hearing shall be held in the District of Columbia in accordance with the provisions of section 554 of title 5, United States Code. The record developed in any such adjudicatory hearing shall be part of the basis for the Administrator's decision to approve or deny a license. Hearings held pursuant to this subsection shall be consolidated insofar as practicable with hearings held by other agencies. All public hearings on all applications with respect to facilities for any designated application area shall be consolidated and shall be concluded not later than 240 days after notice of the initial application has been published pursuant to subsection (d) of this section. All public hearings on applications with respect to ocean thermal energy conversion plantships shall be concluded not later than 240 days after notice of the application has been published pursuant to subsection (d) of this section.

Notice, comments, and hearings.

Record.

Consolidation of hearings.

(h) Each person applying for a license pursuant to this Act shall remit to the Administrator at the time the application is filed a nonrefundable application fee, which shall be deposited into miscellaneous receipts of the Treasury. The amount of the fee shall be established by regulation by the Administrator, and shall reflect the reasonable administrative costs incurred in reviewing and processing the application.

Application fee.

(i)(1) The Administrator shall approve or deny any timely filed application with respect to a facility for a designated application area submitted in accordance with the provision of this Act not later than 90 days after public hearings on proposed licenses for that area are concluded pursuant to subsection (g) of this section. The Administrator shall approve or deny an application for a license for ownership, construction, and operation of an ocean thermal energy conversion plantship submitted pursuant to this Act no later than 90 days after the public hearings on that application are concluded pursuant to subsection (g) of this section.

Application approval or denial.

(2) In the event more than one application for a license for ownership, construction, and operation of an ocean thermal energy conversion facility is submitted pursuant to this Act for the same designated application area, the Administrator, unless one or a specific combination of the proposed facilities clearly best serves the

Applications for same area.

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national interest, shall make decisions on license applications in the order in which they were submitted to him.

Facility selection, determination factors.

(3) In determining whether any one or a specific combination of the proposed ocean thermal energy conversion facilities clearly best serves the national interest, the Administrator, in consultation with the Secretary of Energy, shall consider the following factors:

(A) the goal of making the greatest possible use of ocean thermal energy conversion by installing the largest capacity practicable in each application area;

(B) the amount of net energy impact of each of the proposed ocean thermal energy conversion facilities;

(C) the degree to which the proposed ocean thermal energy conversion facilities will affect the environment;

(D) any significant differences between anticipated dates and commencement of operation of the proposed ocean thermal energy conversion facilities; and

(E) any differences in costs of construction and operation of the proposed ocean thermal energy conversion facilities, to the extent that such differentials may significantly affect the ultimate cost of energy or products to the consumer.

42 USC 9113.

SEC. 103. PROTECTION OF SUBMARINE ELECTRIC TRANSMISSION CABLES AND EQUIPMENT.

Penalties and fines.

(a) Any person who shall willfully and wrongfully break or injure, or attempt to break or injure, or who shall in any manner procure, counsel, aid, abet, or be accessory to such breaking or injury, or attempt to break or injure, any submarine electric transmission cable or equipment being constructed or operated under a license issued pursuant to this Act shall be guilty of a misdemeanor and, on conviction thereof, shall be liable to imprisonment for a term not exceeding 2 years, or to a fine not exceeding $5,000, or to both fine and imprisonment, at the discretion of the court.

(b) Any person who by culpable negligence shall break or injure any submarine electric transmission cable or equipment being constructed or operated under a license issued pursuant to this Act shall be guilty of a misdemeanor and, on conviction thereof, shall be liable to imprisonment for a term not exceeding 3 months, or to a fine not exceeding $500, or to both fine and imprisonment, at the discretion of the court.

(c) The provisions of subsections (a) and (b) of this section shall not apply to any person who, after having taken all necessary precautions to avoid such breaking or injury, breaks or injures any submarine electric transmission cable or equipment in an effort to save the life or limb of himself or of any other person, or to save his own or any other vessel.

Suit for damages.

(d) The penalties provided in subsections (a) and (b) of this section for the breaking or injury of any submarine electric transmission cable or equipment shall not be a bar to a suit for damages on account of such breaking or injury.

Indemnity.

(e) Whenever any vessel sacrifices any anchor, fishing net, or other fishing gear to avoid injuring any submarine electric transmission cable or equipment being constructed or operated under a license issued pursuant to this Act, the licensee shall indemnify the owner of such vessel for the items sacrificed: *Provided*, That the owner of the vessel had taken all reasonable precautionary measures beforehand.

Repair cost.

(f) Any licensee who causes any break in or injury to any submarine cable or pipeline of any type shall bear the cost of the repairs.

SEC. 104. ANTITRUST REVIEW. 42 USC 9114.

(a) Whenever any application for issuance, transfer, or renewal of any license is received, the Administrator shall transmit promptly to the Attorney General a complete copy of such application. Within 90 days of the receipt of the application, the Attorney General shall conduct such antitrust review of the application as he deems appropriate, and submit to the Administrator any advice or recommendations he deems advisable to avoid any action upon such application by the Administrator which would create a situation inconsistent with the antitrust laws. If the Attorney General fails to file such views within the 90-day period, the Administrator shall proceed as if such views had been received. The Administrator shall not issue, transfer, or renew the license during the 90-day period, except upon written confirmation by the Attorney General that he does not intend to submit any further advice or recommendation on the application during such period. Application copy, transmittal to Attorney General.

(b) The issuance of a license under this Act shall not be admissible in any way as a defense to any civil or criminal action for violation of the antitrust laws of the United States, nor shall it in any way modify or abridge any private right of action under such laws. Nothing in this section shall be construed to bar the Attorney General or the Federal Trade Commission from challenging any anticompetitive situation involved in the ownership, construction, or operation of an ocean thermal energy conversion facility or plantship.

SEC. 105. ADJACENT COASTAL STATES. 42 USC 9115.

(a)(1) The Administrator, in issuing notice of application pursuant to section 102(d) of this title, shall designate as an "adjacent coastal State" any coastal State which (A) would be directly connected by electric transmission cable or pipeline to an ocean thermal energy conversion facility as proposed in an application, or (B) in whose waters any part of such proposed ocean thermal energy conversion facility would be located, or (C) in whose waters an ocean thermal energy conversion plantship would be operated as proposed in an application.

(2) The Administrator shall, upon request of a State, designate such State as an "adjacent coastal State" if he determines that (A) there is a risk of damage to the coastal environment of such State equal to or greater than the risk posed to a State required to be designated as an "adjacent coastal State" by paragraph (1) of this subsection or (B) that the thermal plume of the proposed ocean thermal energy conversion facility or plantship is likely to impinge on so as to degrade the thermal gradient at possible locations for ocean thermal energy conversion facilities which could reasonably be expected to be directly connected by electric transmission cable or pipeline to such State. This paragraph shall apply only with respect to requests made by a State not later than the 14th day after the date of publication of notice of application for a proposed ocean thermal energy conversion facility in the Federal Register in accordance with section 102(d) of this title. The Administrator shall make any designation required by this paragraph not later than the 45th day after the date he receives such a request from a State. Publication in Federal Register.

(b)(1) Not later than 5 days after the designation of adjacent coastal State pursuant to this section, the Administrator shall transmit a complete copy of the application to the Governor of such State. The Administrator shall not issue a license without consultation with the Governor of each adjacent coastal State which has an approved coastal zone management program in good standing pursuant to the Application copy, transmittal to State Governor.

Coastal Zone Management Act of 1972 (16 U.S.C. 1451 et seq.). If the Governor of such a State has not transmitted his approval or disapproval to the Administrator by the 45th day after public hearings on the application is concluded pursuant to section 102(g) of this title, such approval shall be conclusively presumed. If the Governor of such a State notifies the Administrator that an application which the Governor would otherwise approve pursuant to this paragraph is inconsistent in some respect with the State's coastal zone management program, the Administrator shall condition the license granted so as to make it consistent with such State program.

(2) Any adjacent coastal State which does not have an approved coastal zone management program in good standing, and any other interested State, shall have the opportunity to make its views known to, and to have them given full consideration by, the Administrator regarding the location, construction, and operation of an ocean thermal energy conversion facility or plantship.

Agreement or compact between States.

(c) The consent of Congress is given to 2 or more States to negotiate and enter into agreements or compacts, not in conflict with any law or treaty of the United States, (1) to apply for a license for the ownership, construction, and operation of an ocean thermal energy conversion facility or plantship or for the transfer of such a license, and (2) to establish such agencies, joint or otherwise, as are deemed necessary or appropriate for implementing and carrying out the provisions of any such agreement or compact. Such agreement or compact shall be binding and obligatory upon any State or other party thereto without further approval by the Congress.

42 USC 9116.

SEC. 106. DILIGENCE REQUIREMENTS.

Regulations.

(a) The Administrator shall promulgate regulations requiring each licensee to pursue diligently the construction and operation of the ocean thermal energy conversion facility or plantship to which the license applies.

License termination.

(b) If the Administrator determines that a licensee is not pursuing diligently the construction and operation of the ocean thermal energy conversion facility or plantship to which the license applies, or that the project has apparently been abandoned, the Administrator shall cause proceedings to be instituted under section 111 of this title to terminate the license.

42 USC 9117.

SEC. 107. PROTECTION OF THE ENVIRONMENT.

Environmental assessment program.

(a) The Administrator shall initiate a program to assess the effects on the environment of ocean thermal energy conversion facilities and plantships. The program shall include baseline studies of locations where ocean thermal energy conversion facilities or plantships are likely to be sited or operated; and research; and monitoring of the effects of ocean thermal energy conversion facilities and plantships in actual operation. The purpose of the program shall be to assess the environmental effects of individual ocean thermal energy facilities and plantships, and to assess the magnitude of any cumulative environmental effects of large numbers of ocean thermal energy facilities and plantships.

(b) The program shall be designed to determine, among other things—

(1) any short-term and long-term effects on the environment which may occur as a result of the operation of ocean thermal energy conversion facilities and plantships;

(2) the nature and magnitude of any oceanographic, atmospheric, weather, climatic, or biological changes in the environ-

ment which may occur as a result of deployment and operation of large numbers of ocean thermal energy conversion facilities and plantships;

(3) the nature and magnitude of any oceanographic, biological or other changes in the environment which may occur as a result of the operation of electric transmission cables and equipment located in the water column or on or in the seabed, including the hazards of accidentally severed transmission cables; and

(4) whether the magnitude of one or more of the cumulative environmental effects of deployment and operation of large numbers of ocean thermal energy conversion facilities and plantships requires that an upper limit be placed on the number or total capacity of such facilities or plantships to be licensed under this Act for simultaneous operation, either overall or within specific geographic areas.

Plan submittal to Congress.

(c) Within 180 days after enactment of this Act, the Administrator shall prepare a plan to carry out the program described in subsections (a) and (b) of this section, including necessary funding levels for the next 5 fiscal years, and submit the plan to the Congress.

(d) The program established by subsections (a) and (b) of this section shall be reduced to the minimum necessary to perform baseline studies and to analyze monitoring data, when the Administrator determines that the program has resulted in sufficient knowledge to make the determinations enumerated in subsection (b) of this section with an acceptable level of confidence.

Environmental impact statement.

(e) The issuance of any license for ownership, construction, and operation of an ocean thermal energy conversion facility or plantship shall be deemed to be a major Federal action significantly affecting the quality of the human environment for purposes of section 102(2)(C) of the National Environmental Policy Act of 1969 (42 U.S.C. 4332(2)(C)). For all timely applications covering proposed facilities in a single application area, and for each application relating to a proposed plantship, the Administrator shall, pursuant to such section 102(2)(C) and in cooperation with other involved Federal agencies and departments, prepare a single environmental impact statement, which shall fulfill the requirement of all Federal agencies in carrying out their responsibilities pursuant to this Act to prepare an environmental impact statement. Each such draft environmental impact statement relating to proposed facilities shall be prepared and published within 180 days after notice of the initial application has been published pursuant to section 102(d) of this title. Each such draft environmental impact statement relating to a proposed plantship shall be prepared and published within 180 days after notice of the application has been published pursuant to section 102(d) of this title. Each final environmental impact statement shall be published not later than 90 days following the date on which public hearings are concluded pursuant to section 102(g) of this title. The Administrator may extend the deadline for publication of a specific draft or final environmental impact statement to a later specified time for good cause shown in writing.

Ante, p. 979.

Hearings.

Vessel or floating craft.

(f) An ocean thermal energy conversion facility or plantship licensed under this title shall be deemed not to be a "vessel or other floating craft" for the purposes of section 502(12)(B) of the Federal Water Pollution Control Act of 1972 (33 U.S.C. 1362(12)(B)).

42 USC 9118.

SEC. 108. MARINE ENVIRONMENTAL PROTECTION AND SAFETY OF LIFE AND PROPERTY AT SEA.

(a) The Secretary of the department in which the Coast Guard is operating shall, subject to recognized principles of international law, prescribe by regulation and enforce procedures with respect to any ocean thermal energy conversion facility or plantship licensed under this Act, including, but not limited to, rules governing vessel movement, procedures for transfer of materials between such a facility or plantship and transport vessels, designation and marking of anchorage areas, maintenance, law enforcement, and the equipment, training, and maintenance required (1) to promote the safety of life and property at sea, (2) to prevent pollution of the marine environment, (3) to clean up any pollutants which may be discharged, and (4) to otherwise prevent or minimize any adverse impact from the construction and operation of such ocean thermal energy conversion facility or plantship.

Regulations.

(b) The Secretary of the department in which the Coast Guard is operating shall issue and enforce regulations, subject to recognized principles of international law, with respect to lights and other warning devices, safety equipment, and other matters relating to the promotion of safety of life and property on any ocean thermal energy conversion facility or plantship licensed under this Act.

(c) Whenever a licensee fails to mark any component of such an ocean thermal energy conversion facility or plantship in accordance with applicable regulations, the Secretary of the department in which the Coast Guard is operating shall mark such components for the protection of navigation, and the licensee shall pay the cost of such marking.

Safety zone.

(d)(1) Subject to recognized principles of international law and after consultation with the Secretary of Commerce, the Secretary of the Interior, the Secretary of State, and the Secretary of Defense, the Secretary of the department in which the Coast Guard is operating shall designate a zone of appropriate size around and including any ocean thermal energy conversion facility licensed under this Act and may designate such a zone around and including any ocean thermal energy conversion plantship licensed under this Act for the purposes of ~~reorganizational~~ safety and protection of the facility or plantship. The Secretary of the department in which the Coast Guard is operating shall by regulation define permitted activities within such zone consistent with the purpose for which it was designated. The Secretary of the department in which the Coast Guard is operating shall, not later than 30 days after publication of notice pursuant to section 102(d) of this title, designate such safety zone with respect to any proposed ocean thermal energy conversion facility or plantship.

NAVIGATIONAL navigation

Rules and regulations

(2) In addition to any other regulations, the Secretary of the department in which the Coast Guard is operating is authorized, in accordance with this subsection, to establish a safety zone to be effective during the period of construction of an ocean thermal energy conversion facility or plantship licensed under this Act, and to issue rules and regulations relating thereto.

Regulations, enforcement and compliance.

(e)(1) The Secretary of the department in which the Coast Guard is operating shall promulgate and enforce regulations specified in paragraph (2) of this subsection and such other regulations as he deems necessary concerning the documentation, design, construction, alteration, equipment, maintenance, repair, inspection, certification, and manning of ocean thermal energy conversion facilities and plantships. In addition to other requirements prescribed under those regulations, the Secretary of the department in which the Coast

Guard is operating may require compliance with those vessel documentation, inspection, and manning laws which he determines to be appropriate.

(2) Within 1 year after the date of enactment of this Act, the Secretary of the department in which the Coast Guard is operating shall promulgate regulations under paragraph (1) of this subsection which require that any ocean thermal energy conversion facility or plantship— Facility or plantship requirements. Regulations.

(A) be documented;

(B) comply with minimum standards of design, construction, alteration, and repair; and

(C) be manned or crewed by United States citizens or aliens lawfully admitted to the United States for permanent residence, unless—

(i) there is not a sufficient number of United States citizens, or aliens lawfully admitted to the United States for permanent residence, qualified and available for such work, or

(ii) the President makes a specific finding, with respect to the particular vessel, platform, or moored or standing structure, that application of this requirement would not be consistent with the national interest.

(3) For the purposes of the documentation laws, for which compliance is required under paragraph (1) of this subsection, ocean thermal energy conversion facilities and plantships shall be deemed to be vessels and, if documented, vessels of the United States for the purposes of the Ship Mortgage Act, 1920 (46 U.S.C. 911–984).

(f) Subject to recognized principles of international law, the Secretary of the department in which the Coast Guard is operating shall promulgate and enforce such regulations as he deems necessary to protect navigation in the vicinity of a vessel engaged in the installation, repair, or maintenance of any submarine electric transmission cable or equipment, and to govern the markings and signals used by such a vessel.

SEC. 109. PREVENTION OF INTERFERENCE WITH OTHER USES OF THE HIGH SEAS. 42 USC 9119.

(a) Each license shall include such conditions as may be necessary and appropriate to ensure that construction and operation of the ocean thermal energy conversion facility or plantship are conducted with reasonable regard for navigation, fishing, energy production, scientific research, or other uses of the high seas, either by citizens of the United States or by other nations in their exercise of the freedoms of the high seas as recognized under the Convention of the High Seas and the general principles of international law.

(b) The Administrator shall promulgate regulations specifying under what conditions and in what circumstances the thermal plume of an ocean thermal energy conversion facility or plantship licensed under this Act will be deemed— Regulations.

(1) to impinge on so as to degrade the thermal gradient used by another ocean thermal energy conversion facility or plantship, or

(2) to impinge on so as to adversely affect the territorial sea or area of natural resource jurisdiction, as recognized by the United States, of any other nation.

Such regulations shall also provide for the Administrator to mediate or arbitrate any disputes among licensees regarding the extent to which the thermal plume of one licensee's facility or plantship impinges on the operation of another licensee's facility or plantship.

(3) Except in a situation involving force majeure, a licensee of an ocean thermal energy conversion facility or plantship shall not permit a vessel, registered in or flying the flag of a foreign state, to call at, load or unload cargo at, or otherwise utilize such a facility or plantship licensed under this Act unless (A) the foreign state involved has agreed, by specific agreement with the United States, to recognize the jurisdiction of the United States over the vessel and its personnel, in accordance with the provisions of this Act, while the vessel is located within the safety zone, and (B) the vessel owner or operator has designated an agent in the United States for receipt of service of process in the event of any claim or legal proceeding resulting from activities of the vessel or its personnel while located within such a safety zone.

Regulations, enforcement.

(c) The Secretary of the department in which the Coast Guard is operating shall promulgate, after consultation with the Administrator, and shall enforce, regulations governing the movement and navigation of ocean thermal energy conversion plantships licensed under this Act to ensure that the thermal plume of such an ocean thermal energy conversion plantship does not unreasonably impinge on so as to degrade the thermal gradient used by the operation of any other ocean thermal energy conversion plantship or facility except in case of force majeure or with the consent of owner of the other such plantship or facility, and to ensure that the thermal plume such of an ocean thermal energy conversion plantship does not impinge on so as to adversely affect the territorial sea or area of national resource jurisdiction, as recognized by the United States, of any other nation unless the Secretary of State has approved such impingment after consultation with such nation.

42 USC 9120.

SEC. 110. MONITORING OF LICENSEES' ACTIVITIES.

Each license shall require the licensee—

(1) to allow the Administrator to place appropriate Federal officers or employees aboard the ocean thermal energy conversion facility or plantship to which the license applies, at such times and to such extent as the Administrator deems reasonable and necessary to assess compliance with any condition or regulation applicable to the license, and to report to the Administrator whenever such officers or employees have reason to believe there is a failure to comply;

(2) to cooperate with such officers and employees in the performance of monitoring functions; and

(3) to monitor the environmental effects, if any, of the operation of the ocean thermal energy conversion facility or plantship in accordance with regulations issued by the Administrator, and to submit such information as the Administrator finds to be necessary and appropriate to assess environmental impacts and to develop and evaluate mitigation methods and possibilities.

42 USC 9121.

SEC. 111. SUSPENSION, REVOCATION, OR TERMINATION OF LICENSE.

(a) Whenever a licensee fails to comply with any applicable provision of this Act or any applicable rule, regulation, restriction, or condition issued or imposed by the Administrator under the authority of this Act, the Attorney General, at the request of the Administrator, shall file an action in the appropriate United States district court to—

(1) suspend the license; or

(2) if such failure is knowing and continues for a period of 30 days after the Administrator mails notification of such failure by registered letter to the licensee at his record post office address, revoke such license.

No proceeding under this section is necessary if the license, by its terms, provides for automatic suspension or termination upon the occurrence of a fixed or agreed upon condition, event, or time.

(b) If the Administrator determines that immediate suspension of the construction or operation of an ocean thermal energy conversion facility or plantship or any component thereof is necessary to protect public health and safety or to eliminate imminent and substantial danger to the environment established by any treaty or convention, the Administrator may order the licensee to cease or alter such construction or operation pending the completion of a judicial proceeding pursuant to subsection (a) of this section.

SEC. 112. RECORDKEEPING AND PUBLIC ACCESS TO INFORMATION. 42 USC 9122.

(a) Each licensee shall establish and maintain such records, make such reports, and provide such information as the Administrator, after consultation with other interested Federal departments and agencies, shall by regulation prescribe to carry out the provisions of this Act. Each licensee shall submit such reports and shall make available such records and information as the Administrator may request. Reports.

(b) Any information reported to or collected by the Administrator under this Act which is exempt from disclosure pursuant to section 552(b)(4) of title 5, United States Code (relating to trade secrets and confidential commercial and financial information), shall not— Confidential information.

(1) be publicly disclosed by the Administrator or by any other officer or employee of the United States, unless the Administrator has—

(A) determined that the disclosure is necessary to protect the public health or safety or the environment against an unreasonable risk of injury, and

(B) notified the person who submitted the information 10 days before the disclosure is to be made, unless the delay resulting from such notice would be detrimental to the public health or safety or the environment, or

(2) be otherwise disclosed except—

(A)(i) to other Federal and adjacent coastal State government departments and agencies for official use,

(ii) to any committee of the Congress of appropriate jurisdiction, or

(iii) pursuant to court order, and

(B) when the administrator has taken appropriate steps to inform the recipient of the confidential nature of the information.

SEC. 113. RELINQUISHMENT OR SURRENDER OF LICENSE. 42 USC 9123.

(a) Any licensee may at any time, without penalty, surrender to the Administrator a license issued to him, or relinquish to the Administrator, in whole or in part, any right to conduct construction or operation of an ocean thermal energy conversion facility or plantship, including part or all of any right of way which may have been granted in conjunction with such license: *Provided*, That such surrender or relinquishment shall not relieve the licensee of any obligation or liability established by this or any other Act, or of any obligation or liability for actions taken by him prior to such surrender or relin- Liability.

quishment, or during disposal or removal of any components required to be disposed of or removed pursuant to this Act.

Right of way.

(b) If part or all of a right of way which is relinquished, or for which the license is surrendered, to the Administrator pursuant to subsection (a) of this section contains an electric transmission cable or pipeline which is used in conjunction with another license for an ocean thermal energy conversion facility, the Administrator shall allow the other licensee an opportunity to add such right of way to his license before informing the Secretary of the Interior that the right of way has been vacated.

42 USC 9124.

SEC. 114. CIVIL ACTIONS.

(a) Except as provided in subsection (b) of this section, any person having a valid legal interest which is or may be adversely affected may commence a civil action for equitable relief on his own behalf in the United States District Court for the District of Columbia whenever such action constitutes a case or controversy—

(1) against any person who is alleged to be in violation of any provision of this Act or any regulation or condition of a license issued pursuant to this Act; or

(2) against the Administrator where there is alleged a failure of the Administrator to perform any act or duty under this Act which is not discretionary.

Suits.

In suits brought under this Act, the district courts of the United States shall have jurisdiction, without regard to the amount in controversy or the citizenship of the parties, to enforce any provision of this Act or any regulation or term or condition of a license issued pursuant to this Act, or to order the Administrator to perform such act or duty, as the case may be.

(b) No civil action may be commenced—

(1) under subsection (a)(1) of this section—

(A) prior to 60 days after the plaintiff has given notice of the violation to the Administrator and to any alleged violator; or

(B) if the Administrator or the Attorney General has commenced and is diligently prosecuting a civil or criminal action with respect to such matters in a court of the United States, but in any such action any person may intervene as a matter of right; or

(2) under subsection (a)(2) of this section prior to 60 days after the plaintiff has given notice of such action to the Administrator.

Notice.

Notice under this subsection shall be given in such a manner as the Administrator shall prescribe by regulation.

(c) In any action under this section, the Administrator or the Attorney General, if not a party, may intervene as a matter of right.

Litigation costs.

(d) The court, in issuing any final order in any action brought pursuant to subsection (a) of this section, may award costs of litigation (including reasonable attorney and expert witness fees) to any party whenever the court determines that such an award is appropriate.

(e) Nothing in this section shall restrict any right which any person or class of persons may have under any statute or common law to seek enforcement or to seek any other relief.

42 USC 9125.

SEC. 115. JUDICIAL REVIEW.

Any person suffering legal wrong, or who is adversely affected or aggrieved by the Administrator's decision to issue, transfer, modify, renew, suspend, or terminate a license may, not later than 60 days

after such decision is made, seek judicial review of such decision in the United States Court of Appeals for the District of Columbia. A person shall be deemed to be aggrieved by the Administrator's decision within the meaning of this Act if he—

(1) has participated in the administrative proceedings before the Administrator (or if he did not so participate, he can show that his failure to do so was caused by the Administrator's failure to provide the required notice); and

(2) is adversely affected by the Administrator's action.

SEC. 116. TEST PLATFORMS AND COMMERCIAL DEMONSTRATION OCEAN THERMAL ENERGY CONVERSION FACILITY OR PLANTSHIP. 42 USC 9126.

(a) The provisions of this title shall not apply to any test platform which will not operate as an ocean thermal energy conversion facility or platform after conclusion of the testing period.

(b) The provisions of this title shall not apply to ownership, construction, or operation of any ocean thermal energy conversion facility or plantship which the Secretary of Energy has designated in writing as a demonstration project for the development of alternative energy sources for the United States which is conducted by, participated in, or approved by the Department of Energy. The Secretary of Energy, after consultation with the Administrator, shall require such demonstration projects to abide by as many of the substantive requirements of this title as he deems to be practicable without damaging the nature of or unduly delaying such projects.

SEC. 117. PERIODIC REVIEW AND REVISION OF REGULATIONS. 42 USC 9127.

The Administrator and the Secretary of the department in which the Coast Guard is operating shall periodically, at intervals of not more than every 3 years, and in consultation with the Secretary of Energy, review any regulations promulgated pursuant to the provisions of this title to determine the status and impact of such regulations on the continued development, evolution, and commercialization of ocean thermal energy conversion technology. The results of each such review shall be included in the next annual report required by section 405. The Administrator and such Secretary are authorized and directed to promulgate any revisions to the then effective regulations as are deemed necessary and appropriate based on such review, to ensure that any regulations promulgated pursuant to the provisions of this title do not impede such development, evolution, and commercialization of such technology. Additionally, the Secretary of Energy is authorized to propose, based on such review, such revisions for the same purpose. The Administrator or such Secretary, as appropriate, shall have exclusive jurisdiction with respect to any such proposal by the Secretary of Energy and, pursuant to applicable procedures, shall consider and take final action on any such proposal in an expeditious manner. Such consideration shall include at least one informal hearing pursuant to the procedures in section 553 of title 5, United States Code.

Review results.

Post, p. 999.

Proposals by Secretary of Energy.

Hearing.

TITLE II—MARITIME FINANCING FOR OCEAN THERMAL ENERGY CONVERSION

SEC. 201. DETERMINATIONS UNDER THE MERCHANT MARINE ACT, 1936. 42 USC 9141.

(a)(1) For the purposes of section 607 of the Merchant Marine Act, 1936 (46 U.S.C. 1177), any ocean thermal energy conversion facility or plantship licensed pursuant to this Act, and any vessel providing shipping service to or from such an ocean thermal energy conversion

facility or plantship, shall be deemed to be a vessel operated in the foreign commerce of the United States.

(2) The provisions of paragraph (1) of this subsection shall apply for taxable years beginning after December 31, 1981.

(b) For the purposes of the Merchant Marine Act, 1936 (46 U.S.C. 1177 et seq.) any vessel documented under the laws of the United States and used in providing shipping service to or from any ocean thermal energy conversion facility or plantship licensed pursuant to the provisions of this Act shall be deemed to be used in, and used in an essential service in, the foreign commerce or foreign trade of the United States, as defined in section 905(a) of the Merchant Marine Act, 1936 (46 U.S.C. 1244(a)).

SEC. 202. AMENDMENTS TO TITLE XI OF THE MERCHANT MARINE ACT, 1936.

(a) Section 1101 of the Merchant Marine Act, 1936 (46 U.S.C. 1271), is amended—

(1) in subsection (b) by striking "and" immediately before "dredges" and inserting in lieu thereof a comma, and by inserting immediately after "dredges" the following: "and ocean thermal energy conversion facilities or plantships",

(2) in subsection (g) by striking "and" after the semicolon,

(3) in subsection (h) by striking "equipping" and inserting in lieu thereof "equipping and", and

(4) by adding at the end thereof a new subsection (i) to read as follows:

Definition.

"(i) The term 'ocean thermal energy conversion facility or plantship' means any at-sea facility or vessel, whether mobile, floating unmoored, moored, or standing on the seabed, which uses temperature differences in ocean water to produce electricity or another form of energy capable of being used directly to perform work, and includes any equipment installed on such facility or vessel to use such electricity or other form of energy to produce, process, refine, or manufacture a product, and any cable or pipeline used to deliver such electricity, freshwater, or product to shore, and all other associated equipment and appurtenances of such facility or vessel, to the extent they are located seaward of the highwater mark.".

(b) Section 1104(a)(1) of the Merchant Marine Act, 1936 (46 U.S.C. 1274(a)(1)), is amended by striking "or (E)" and inserting in lieu thereof "(E) as an ocean thermal energy conversion facility or plantship; or (F)".

(c) Section 1104(b)(2) of the Merchant Marine Act, 1936 (46 U.S.C. 1274(b)(2)), is amended by striking "vessel;" and inserting in lieu thereof "vessel: *Provided further,* That in the case of an ocean thermal energy conversion facility or plantship which is constructed without the aid of construction-differential subsidy, such obligations may be in an aggregate principal amount which does not exceed 87½ percent of the actual cost or depreciated actual cost of the facility or plantship;".

SEC. 203. OTEC DEMONSTRATION FUND.

(a) Title XI of the Merchant Marine Act, 1936 (46 U.S.C. 1271-1279b) is further amended by adding at the end thereof a new section 1110 to read as follows:

Guarantees.
46 USC 1279c.
46 USC 1273.

"SEC. 1110. (a) Pursuant to the authority granted under section 1103(a) of this title, the Secretary of Commerce, upon such terms as he shall prescribe, may guarantee or make a commitment to guarantee, payment of the principal of and interest on an obligation which

aids in financing, including reimbursement of an obligor for expenditures previously made for, construction, reconstruction, or reconditioning of a commercial demonstration ocean thermal energy conversion facility or plantship owned by citizens of the United States. Guarantees or commitments to guarantee under this subsection shall be subject to all the provisos, requirements, regulations, and procedures which apply to guarantees or commitments to guarantee made pursuant to section 1104(a)(1) of this title, except that—

46 USC 1274.
Exceptions.

"(1) no guarantees or commitments to guarantee may be made by the Secretary of Commerce under this subsection before October 1, 1981;

"(2) the provisions of subsection (d) of section 1104 of this title shall apply to guarantees or commitments to guarantee for that portion of a commercial demonstration ocean thermal energy conversion facility or plantship not to be supported with appropriated Federal funds;

"(3) guarantees or commitments to guarantee made pursuant to this section may be in an aggregate principal amount which does not exceed 87½ percent of the actual cost or depreciated actual cost of the commercial demonstration ocean thermal energy conversion facility or plantship: *Provided*, That, if the commercial demonstration ocean thermal energy conversion facility or plantship is supported with appropriated Federal funds, such guarantees or commitments to guarantee may not exceed 87½ percent of the aggregate principal amount of that portion of the actual cost or depreciated actual cost for which the obligor has an obligation to secure financing in accordance with the terms of the agreement between the obligor and the Department of Energy or other Federal agency; and

"(4) the provisions of this section may be used to guarantee obligations for a total of not more than 5 separate commercial demonstration ocean thermal energy conversion facilities and plantships or a demonstrated 400 megawatt capacity, whichever comes first.

"(b) A guarantee or commitment to guarantee shall not be made under this section unless the Secretary of Energy, in consultation with the Secretary of Commerce, certifies to the Secretary of Commerce that, for the ocean thermal energy conversion facility or plantship for which the guarantee or commitment to guarantee is sought, there is sufficient guarantee of performance and payment to lower the risk to the Federal Government to a level which is reasonable. The Secretary of Energy must base his considerations on the following: (1) the successful demonstration of the technology to be used in such facility at a scale sufficient to establish the likelihood of technical and economic viability in the proposed market; and (2) the need of the United States to develop new and renewable sources of energy and the benefits to be realized from the construction and successful operation of such facility or plantship.

"(c) A special subaccount in the Federal Ship Financing Fund, to be known as the OTEC Demonstration Fund, shall be established on October 1, 1981. The OTEC Demonstration Fund shall be used for obligation guarantees authorized under this section which do not qualify under other sections of this title. Except as specified otherwise in this section, the operation of the OTEC Demonstration Fund shall be identical with that of the parent Federal Ship Financing Fund: except that, notwithstanding the provisions of section 1104(g), (1) all moneys received by the Secretary pursuant to sections 1101 through 1107 of this title with respect to guarantees or commitments

OTEC Demonstration Fund.

46 USC 1274.

46 USC 1271-1279.

Notes or obligations. 46 USC 1275.

46 USC 1271-1279.

Transfer of assets.

to guarantee made pursuant to this section shall be deposited only in the OTEC Demonstration Fund, and (2) whenever there shall be outstanding any notes or other obligations issued by the Secretary of Commerce pursuant to section 1105(d) of this title with respect to the OTEC Demonstration Fund, all moneys received by the Secretary of Commerce pursuant to sections 1101 through 1107 of this title with respect to ocean thermal energy conversional facilities or plantships shall be deposited in the OTEC Demonstration Fund. Assets in the OTEC Demonstration Fund may at any time be transferred to the parent fund whenever and to the extent that the balance thereof exceeds the total guarantees or commitments to guarantee made pursuant to this section then outstanding, plus any notes or other obligations issued by the Secretary of Commerce pursuant to section 1105(d) of this title with respect to the OTEC Demonstration Fund. The Federal Ship Financing Fund shall not be liable for any guarantees or commitments to guarantee issued pursuant to this section. The aggregate unpaid principal amount of the obligations guaranteed with the backing of the OTEC Demonstration Fund and outstanding at any one time shall not exceed $2,000,000,000.

Notes or obligations. 46 USC 1275.

"(d) The provisions of section 1105(d) of this title shall apply specifically to the OTEC Demonstration Fund as well as to the Fund: *Provided, however,* That any notes or obligations issued by the Secretary of Commerce pursuant to section 1105(d) of this title with respect to the OTEC Demonstration Fund shall be payable solely from proceeds realized by the OTEC Demonstration Fund.

Interest.

26 USC 1 *et seq.*

"(e) The interest on any obligation guaranteed under this section shall be included in gross income for purposes of chapter 1 of the Internal Revenue Code of 1954.".

(b)(1) Section 1103(f) of the Merchant Marine Act, 1936 (46 U.S.C. 1273(f)) is amended by striking out "$10,000,000,000." and inserting in lieu thereof "$12,000,000,000, of which $2,000,000,000 shall be limited to obligations pertaining to commercial demonstration ocean thermal energy conversion facilities or plantships guaranteed pursuant to section 1110 of this title.".

Ante, p. 992.

Effective date. 46 USC 1273 note.

(2) The amendment made by paragraph (1) of this subsection shall take effect October 1, 1981.

TITLE III—ENFORCEMENT

42 USC 9151.

SEC. 301. PROHIBITED ACTS.

It is unlawful for any person who is a United States citizen or national, or a foreign national on board an ocean thermal energy conversion facility or plantship or other vessel documented or numbered under the laws of the United States, or who is subject to the jurisdiction of the United States by an international agreement to which the United States is a party—

(1) to violate any provision of this Act, or any rule, regulation, or order issued pursuant to this Act, or any term or condition of any license issued to such person pursuant to this Act;

(2) to refuse to permit any Federal officer or employee authorized to monitor or enforce the provisions of sections 110 and 303 of this Act to board an ocean thermal energy conversion facility or plantship or any vessel documented or numbered under the laws of the United States, for purposes of conducting any search or inspection in connection with the monitoring or enforcement of this Act or any rule, regulation, order, term, or condition referred to in paragraph (1) of this section;

(3) to forcibly assault, resist, oppose, impede, intimidate, or interfere with any such authorized officer or employee in the conduct of any search or inspection described in paragraph (2) of this section;

(4) to resist a lawful arrest for any act prohibited by this section; or

(5) to interfere with, delay, or prevent, by any means, the apprehension or arrest of another person subject to this section knowing that the other person has committed any act prohibited by this section.

SEC. 302. REMEDIES AND PENALTIES. 42 USC 9152.

Orders, issuance and enforcement.

(a)(1) The Administrator or his delegate shall have the authority to issue and enforce orders during proceedings brought under this Act. Such authority shall include the authority to issue subpenas, administer oaths, compel the attendance and testimony of witnesses and the production of books, papers, documents, and other evidence, to take depositions before any designated individual competent to administer oaths, and to examine witnesses.

(2) Whenever on the basis of any information available to him the Administrator finds that any person subject to section 301 of this title is in violation of any provision of this Act or any rule, regulation, order, license, or term or condition thereof, or other requirements under this Act, he may issue an order requiring such person to comply with such provision or requirement, or bring a civil action in accordance with subsection (b) of this section.

(3) Any compliance order issued under this subsection shall state with reasonable specificity the nature of the violation and a time for compliance, not to exceed 30 days, which the Administrator determines is reasonable, taking into account the seriousness of the violation and any good faith efforts to comply with applicable requirements.

(b)(1) Upon a request by the Administrator, the Attorney General shall commence a civil action for appropriate relief, including a permanent or temporary injunction, any violation for which the Administrator is authorized to issue a compliance order under subsection (a)(2) of this section.

(2) Upon a request by the Administrator, the Attorney General shall bring an action in an appropriate district court of the United States for equitable relief to redress a violation, by any person subject to section 301 of this title, of any provision of this Act, any regulation issued pursuant to this Act, or any license condition.

Liability.

(c)(1) Any person who is found by the Administrator, after notice and an opportunity for a hearing in accordance with section 554 of title 5, United States Code, to have committed an act prohibited by section 301 of this title shall be liable to the United States for a civil penalty, not to exceed $25,000 for each violation. Each day of a continuing violation shall constitute a separate violation. The amount of such civil penalty shall be assessed by the Administrator, or his designee, by written notice. In determining the amount of such penalty, the Administrator shall take into account the nature, circumstances, extent and gravity of the prohibited acts committed and, with respect to the violator, the degree of culpability, any history of prior offenses, ability to pay, and such other matters as justice may require.

Review.

(2) Any person against whom a civil penalty is assessed under paragraph (1) of this subsection may obtain a review thereof in the appropriate court of the United States by filing a notice of appeal in

such court within 30 days from the date of such order and by simultaneously sending a copy of such notice by certified mail to the Administrator. The Administrator shall promptly file in such court a certified copy of the record upon which such violation was found or such penalty imposed, as provided in section 2112 of title 28, United States Code. The findings and order of the Administrator shall be set aside by such court if they are not found to be supported by substantial evidence, as provided in section 706(2) of title 5, United States Code.

Filing of certified copy.

Assessment, failure to pay.

(3) If any person subject to section 301 fails to pay an assessment of a civil penalty against him after it has become final, or after the appropriate court has entered final judgment in favor of the Administrator, the Administrator shall refer the matter to the Attorney General of the United States, who shall recover the amount assessed in any appropriate court of the United States. In such action, the validity and appropriateness of the final order imposing the civil penalty shall not be subject to review.

Review.

(4) The Administrator may compromise, modify, or remit, with or without conditions, any civil penalty which is subject to imposition or which has been imposed under this subsection.

(d)(1) Any person subject to section 301 of this title is guilty of an offense if he willfully commits any act prohibited by such section.

(2) Any offense, other than an offense for which the punishment is prescribed by section 103 of this Act, is punishable by a fine of not more than $75,000 for each day during which the violation continues. Any offense described in paragraphs (2), (3), (4), and (5) of section 301 is punishable by the fine or imprisonment for not more than 6 months, or both. If, in the commission of any offense, the person subject to section 301 uses a dangerous weapon, engages in conduct that causes bodily injury to any Federal officer or employee, or places any Federal officer or employee in fear of imminent bodily injury, the offense is punishable by a fine of not more than $100,000 or imprisonment for not more than 10 years, or both.

(e) Any ocean thermal energy conversion facility or plantship licensed pursuant to this Act and any other vessel documented or numbered under the laws of the United States, except a public vessel engaged in noncommercial activities, used in any violation of this Act or of any rule, regulation, order, license, or term or condition thereof, or other requirements of this Act, shall be liable in rem for any civil penalty assessed or criminal fine imposed and may be proceeded against in any district court of the United States having jurisdiction thereof, whenever it shall appear that one or more of the owners, or bareboat charterers, was at the time of the violation a consenting party or privy to such violation.

42 USC 9153.

SEC. 303. ENFORCEMENT.

Responsibility of NOAA Administrator.

(a) Except where a specific section of this Act designates enforcement responsibility, the provisions of this Act shall be enforced by the Administrator. The Secretary of the department in which the Coast Guard is operating shall have exclusive responsibility for enforcement measures which affect the safety of life and property at sea, shall exercise such other enforcement responsibilities with respect to vessels subject to the provisions of this Act as are authorized under other provisions of law, and may, upon the specific request of the Administrator, assist the Administrator in the enforcement of any provision of this Act. The Administrator and the Secretary of the department in which the Coast Guard is operating may, by agreement, on a reimbursable basis or otherwise, utilize the personnel,

services, equipment, including aircraft and vessels, and facilities of any other Federal agency or department, and may authorize officers or employees of other departments or agencies to provide assistance as necessary in carrying out subsection (b) of this section. The Administrator and the Secretary of the department in which the Coast Guard is operating may issue regulations jointly or severally as may be necessary and appropriate to carry out their duties under this section.

(b) To enforce the provisions of this Act on board any ocean thermal energy conversion facility or plantship or other vessel subject to the provisions of this Act, any officer who is authorized by the Administrator or the Secretary of the department in which the Coast Guard is operating may—

(1) board and inspect any vessel which is subject to the provisions of this Act;

(2) search the vessel if the officer has reasonable cause to believe that the vessel has been used or employed in the violation of any provision of this Act;

(3) arrest any person subject to section 301 of this title if the officer has reasonable cause to believe that the person has committed a criminal act prohibited by sections 301 and 302(d) of this title;

(4) seize the vessel together with its gear, furniture, appurtenances, stores, and cargo, used or employed in, or with respect to which it reasonably appears that such vessel was used or employed in, the violation of any provision of this Act if such seizure is necessary to prevent evasion of the enforcement of this Act;

(5) seize any evidence related to any violation of any provision of this Act;

(6) execute any warrant or other process issued by any court of competent jurisdiction; and

(7) exercise any other lawful authority.

(c) Except as otherwise specified in section 115 of this Act, the district courts of the United States shall have exclusive original jurisdiction over any case or controversy arising under the provisions of this Act. Except as otherwise specified in this Act, venue shall lie in any district wherein, or nearest to which, the cause of action arose, or wherein any defendant resides, may be found, or has his principal office. In the case of Guam, and any Commonwealth, territory, or possession of the United States in the Pacific Ocean, the appropriate court is the United States District Court for the District of Guam, except that in the case of American Samoa, the appropriate court is the United States District Court for the District of Hawaii. Any such court may, at any time—

(1) enter restraining orders or prohibitions;

(2) issue warrants, process in rem, or other process;

(3) prescribe and accept satisfactory bonds or other security; and

(4) take such other actions as are in the interest of justice.

Definitions.

(d) For the purposes of this section, the term "vessel" includes an ocean thermal energy conversion facility or plantship, and the term "provisions of this Act" or "provision of this Act" includes any rule, regulation, or order issued pursuant to this Act and any term or condition of any license issued pursuant to this Act.

TITLE IV—MISCELLANEOUS PROVISIONS

42 USC 9161.

SEC. 401. EFFECT OF LAW OF THE SEA TREATY.

If the United States ratifies a treaty, which includes provisions with respect to jurisdiction over ocean thermal energy conversion activities, resulting from any United Nations Conference on the Law of the Sea, the Administrator, after consultation with the Secretary of State, shall promulgate any amendment to the regulations promulgated under this Act which is necessary and appropriate to conform such regulations to the provisions of such treaty, in anticipation of the date when such treaty shall come into force and effect for, or otherwise be applicable to, the United States.

42 USC 9162.

SEC. 402. INTERNATIONAL NEGOTIATIONS.

The Secretary of State, in cooperation with the Administrator and the Secretary of the department in which the Coast Guard is operating, shall seek effective international action and cooperation in support of the policy and purposes of this Act and may initiate and conduct negotiations for the purpose of entering into international agreements designed to guarantee noninterference of ocean thermal energy conversion facilities and plantships with the thermal gradients used by other such facilities and plantships, to assure protection of such facilities and plantships and of navigational safety in the vicinity thereof, and to resolve such other matters relating to ocean thermal energy conversion facilities and plantships as need to be resolved in international agreements.

42 USC 9163.

SEC. 403. RELATIONSHIP TO OTHER LAWS.

(a)(1) The Constitution, laws, and treaties of the United States shall apply to an ocean thermal energy conversion facility or plantship licensed under this Act and to activities connected, associated, or potentially interfering with the use or operation of any such facility or plantship, in the same manner as if such facility or plantship were an area of exclusive Federal jurisdiction located within a State. Nothing in this Act shall be construed to relieve, exempt, or immunize any person from any other requirement imposed by Federal law, regulation, or treaty.

(2) Ocean thermal energy conversion facilities and plantships licensed under this Act do not possess the status of islands and have no territorial seas of their own.

(b)(1) Except as may otherwise be provided by this Act, nothing in this Act shall in any way alter the responsibilities and authorities of a State or the United States within the territorial seas of the United States.

(2) The law of the nearest adjacent coastal State to which an ocean thermal energy conversion facility located beyond the territorial sea and licensed under this Act is connected by electric transmission cable or pipeline, now in effect or hereafter adopted, amended, or repealed, is declared to be the law of the United States, and shall apply to such facility, to the extent applicable and not inconsistent with any provision or regulation under this Act or other Federal laws and regulations now in effect or hereafter adopted, amended, or repealed: *Provided, however,* That the application of State taxation laws is not extended hereby outside the seaward boundary of any State. All such applicable laws shall be administered and enforced by the appropriate officers and courts of the United States outside the seaward boundary of any State.

Enforcement.

(c)(1) For the purposes of the customs laws administered by the Secretary of the Treasury, ocean thermal energy conversion facilities and plantships documented under the laws of the United States and licensed under this Act shall be deemed to be vessels.

(2) Except insofar as they apply to vessels documented under the laws of the United States, the customs laws administered by the Secretary of the Treasury shall not apply to any ocean thermal energy conversion facility or plantship licensed under the provisions of this Act, but all foreign articles to be used in the construction of any such facility or plantship, including any component thereof, shall first be made subject to all applicable duties and taxes which would be imposed upon or by reason of their importation if they were imported for consumption in the United States. Duties and taxes shall be paid thereon in accordance with laws applicable to merchandise imported into the customs territory of the United States.

SEC. 404. SUBMARINE ELECTRIC TRANSMISSION CABLE AND EQUIPMENT SAFETY. 42 USC 9164.

(a) The Secretary of Energy, in cooperation with other interested Federal agencies and departments, shall establish and enforce such standards and regulations as may be necessary to assure the safe construction and operation of submarine electric transmission cables and equipment subject to the jurisdiction of the United States. Such standards and regulations shall include, but not be limited to, requirements for the use of the safest and best available technology for submarine electric transmission cable shielding, and for the use of automatic switches to shut off electric current in the event of a break in such a cable. Safety standards and regulations.

(b) The Secretary of Energy, in cooperation with other interested Federal agencies and departments, is authorized and directed to report to the Congress within 60 days after the date of enactment of this Act on appropriations and staffing needed to monitor submarine electric transmission cables and equipment subject to the jurisdiction of the United States so as to assure that they meet all applicable standards for construction, operation, and maintenance. Report to Congress.

SEC. 405. ANNUAL REPORT. 42 USC 9165.

Within 6 months after the end of each of the first 3 fiscal years after the date of enactment of this Act, the Administrator shall submit to the President of the Senate and the Speaker of the House of Representatives a report on the administration of this Act during such fiscal year. Such report shall include, with respect to the fiscal year covered by the report— Submittal to President of Senate and Speaker of House.

(1) a description of progress in implementing this Act;

(2) a list of all licenses issued, suspended, revoked, relinquished, surrendered, terminated, renewed, or transferred; denials of issuance of licenses; and required suspensions and modifications of activities under licenses;

(3) a description of ocean thermal energy conversion activities undertaken pursuant to licenses;

(4) the number and description of all civil and criminal proceedings instituted under title III of this Act, and the current status of such proceedings; and

(5) such recommendations as the Administrator deems appropriate for amending this Act.

42 USC 9166.

SEC. 406. AUTHORIZATION OF APPROPRIATIONS.

There are authorized to be appropriated to the Secretary of Commerce, for the use of the Administrator in carrying out the provisions of this Act, not to exceed $3,000,000 for the fiscal year ending September 30, 1981, not to exceed $3,500,000 for the fiscal year ending September 30, 1982, and not to exceed $3,500,000 for the fiscal year ending September 30, 1983.

42 USC 9167.

SEC. 407. SEVERABILITY.

If any provision of this Act or any application thereof is held invalid, the validity of the remainder of the Act, or any other application, shall not be affected thereby.

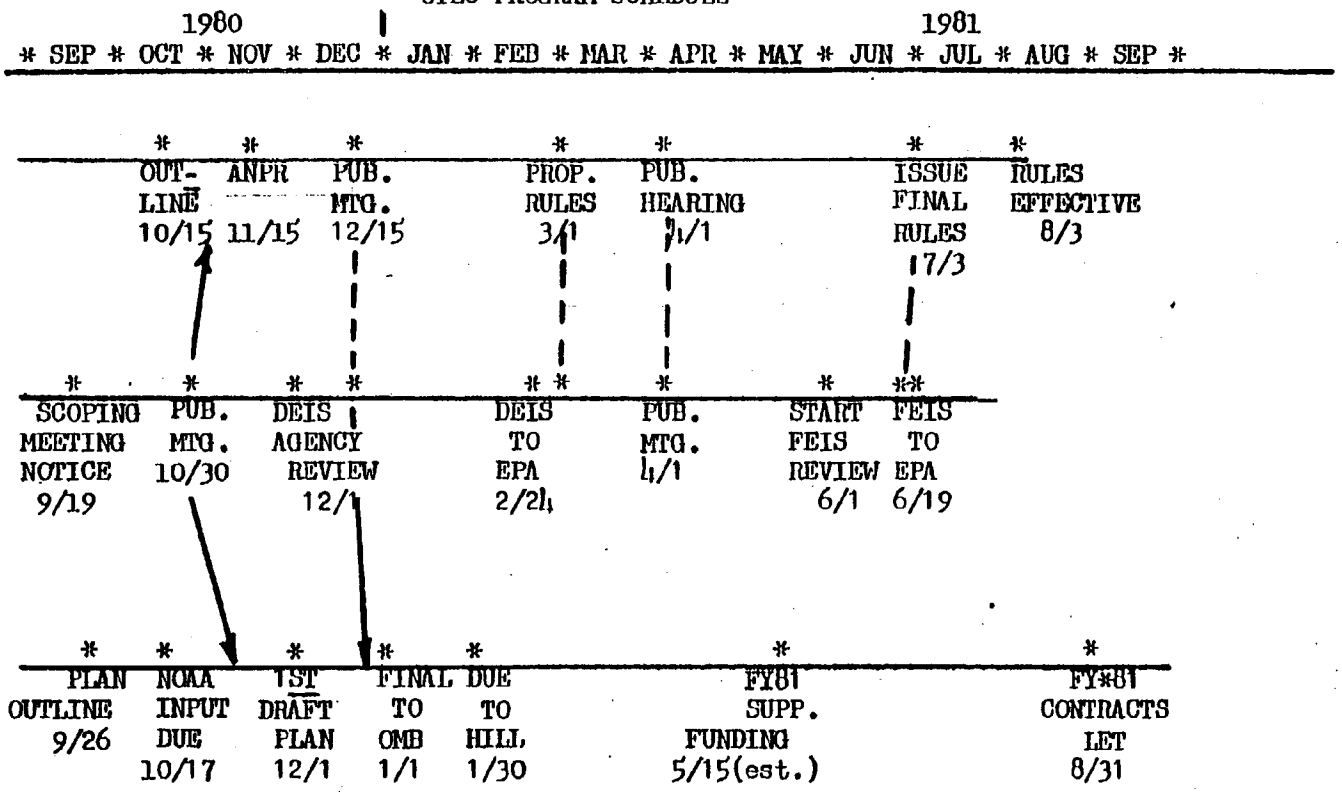
Approved August 3, 1980.

LEGISLATIVE HISTORY:

HOUSE REPORT No. 96-994 accompanying H.R. 6154 (Comm. on Merchant Marine and Fisheries).
SENATE REPORT No. 96-721 (Comm. on Commerce, Science, and Transportation).
CONGRESSIONAL RECORD, Vol. 126 (1980):
July 2, considered and passed Senate.
July 21, H.R. 6154 considered and passed House; passage vacated and S. 2492 passed in lieu.
WEEKLY COMPILATION OF PRESIDENTIAL DOCUMENTS, Vol. 16, No. 32:
Aug. 4, Presidential statement.

9/17/80

OTEC PROGRAM SCHEDULE



APPENDIX C
GLOSSARY

ABUNDANCE	Relative degree of plentifulness.
AMBIENT	Pertaining to the existing conditions of the surrounding environment.
ATMOSPHERE	A unit of pressure equal to the air pressure at mean sea level, comparable to a 760 mm column of mercury.
BACKGROUND LEVEL	The naturally-occurring level of a substance within an environment prior to the unnatural additions of that substance.
BAR SCREEN	Heavy gauge bars which prevent damage to static or traveling screens by large objects.
BATHYPELAGIC ZONE	The biogeographic realm of the ocean lying between depths of 1,000 and 4,000 m.
BENTHOS	A category of marine organisms which live on, in, or near the bottom of the ocean.
BIOCIDE	A substance which is capable of destroying living organisms.
BIOFOULING	The adhesion of various marine organisms to underwater structures.
BIOTA	Pertaining to life and living organisms, collectively plants and animals.
BIOTIC GROUPS	Organisms which are ecologically, structurally, or taxonomically grouped.
BIOMASS	The weight of living matter, including stored food, present in a population and expressed in terms of a given area of the water column or volume of habitat.
BLOOM	An enormous concentration of plankton in an area, caused either by sudden or gradual multiplications of organisms.
CARBONATES	Salts or esters of carbonic acid.
CEPHALOPODS	A subgroup within the phylum mollusca. Typical members include the squid and the octopus.
CHLOROPHYLL	A group of green pigments which occur chiefly in intercellular bodies called chloroplasts, active in photosynthesis.

CHLOROPHYLL *a*	A pigment used in photosynthesis which serves as a convenient measure of phytoplankton biomass.
CIRCULATION PATTERN	The general geometric configuration of oceanic currents usually applied in synoptic oceanography.
CLOSED-CYCLE SYSTEM	A system in which the working fluid does not enter or leave the system, but is used repeatedly.
COLD WATER PIPE	That component of the OTEC plant which extends down to approximately 1000 m in the sea, through which the cold water is drawn to condense the working fluid.
CONDENSERS	The portion of heat exchangers which conducts heat from the gaseous working fluid to the cold water drawn from the cold water pipe. In the process the vapor is changed or "condensed" from a gas to a liquid.
CORROSION	The gradual erosion of a surface, especially by chemical means.
CRUSTACEANS	Animals with jointed appendages and a segmented external skeleton composed of a hard shell or cruse. The group includes barnacles, crabs, shrimps, and lobsters.
DENSITY	The mass per unit volume of a substance.
DIATOM	A minute, free-floating algae with an external skeleton of silica, abundant world wide.
DIFFUSER	The section of discharge pipe which is modified, usually through the addition of numerous ports or holes, to promote rapid mixing of the discharge with the ambient waters.
DIFFUSION	Transfer of material (e.g., salt) or a property (e.g., temperature) by eddies or molecular movement. Diffusion causes dissemination of matter under the influence of a concentration gradient, with movement from the stronger to the weaker solution.
DILUTION	A reduction in concentration through the addition of ambient waters.
DINOFLAGELLATES	Microscopic, planktonic organisms, which may possess characteristics of both plants (photosynthesis) and animals (ingestion of food); abundant world-wide.
DISCHARGE PLUME	The fluid volume derived from the discharge pipe which is distinguishable from the surrounding water.
DISPERSION	Dissemination of discharged water over large areas by the natural processes of ocean turbulence and ocean currents.

DISSOLVED OXYGEN	Amount of oxygen dissolved in a unit volume of water; usually expressed in ml/liter at standard temperature and pressure.
DISSOLVED SOLIDS	The dissipation of solid matter in solution, e.g., salt dissolved in water.
DIVERSITY	A measure of the variety of species in a community which takes into account the relative abundance of each species.
ECOSYSTEM	An ecological community together with its physical environment, considered as a unit, each influencing the properties of the other, and each necessary to the maintenance of life.
ENTRAINMENT	(1) The process by which organisms are drawn into the intake pipes of OTEC; (2) the process by which ambient waters are mixed with the discharge plume.
EPIPELAGIC	Ocean zone ranging from the surface to 200 m in depth.
EROSION	The group of natural processes including weathering, dissolution, abrasion, and corrosion by which the surface is removed from a metal.
EVAPORATOR	The chamber in which the working fluid is vaporized to a gas prior to passing through the turbine.
FAR-FIELD	A somewhat arbitrary cutoff point between regions, where the mixing of discharge is governed by the discharge momentum, and the region where natural ocean turbulence becomes the dominant factor in further mixing of the discharge waters.
FAUNA	The animal population of a particular location, region, or period.
FLORA	The plant population of a particular location, region, or period.
GELATINOUS ORGANISMS	A general term used to describe the large organisms composed of a jelly-like substance, including the cnidarians, salps, siphonores, and ctenophores; jellyfish.
HEAT EXCHANGER	A material (usually metal) with a high coefficient of thermal conductance which is used to exchange heat between the working fluid and the heat source or sink.
HEAVY METALS OR ELEMENTS	Elements which possess a specific gravity of 5.0 or greater.

ICHTHYOPKANKTON	Fish eggs and weakly motile fish larvae.
IMPINGEMENT	A situation in which an organism is forced against a barrier, such as an intake screen, as a result of the intake of water into a facility, such as a powerplant.
INDIGENOUS	Having originated in and being produced, growing, or living naturally in a particular region or environment.
INFAUNA	Animals which live buried in soft substrata.
INITIAL MIXING	That dispersion or diffusion of liquid, suspended particulate, and solid phases of a material which occurs within 4 hours after dumping.
MACROZOOPLANKTON	Planktonic organisms with lengths between 200 and 2,000 microns, composed mainly of copepods, chaetognaths, and larval forms.
M.A.N. BRUSHES	Brushes which travel through heat exchanger tubes for removal of microbial slime.
MARINE	Pertaining to the sea.
MEGAWATT (MW)	One million watts. A watt is a unit of power. It is the amount of work done per unit time and is equal to one joule/sec. One horsepower is equal to 746 watts.
MEROPLANKTON	Organisms which spend only a portion of their life cycle as plankton; usually composed of floating developmental stages (i.e., eggs and larvae) of the benthos and nekton organisms. Also known as temporary plankton.
MESOPELAGIC	Relating to the oceanic depths between 200 m to 1,000 m.
MICROFLAGELLATES	Protozoans which possess flagella as adult locomotor organelles; generally considered to be the most primitive of the protozoans.
MICRONEKTON	Organisms commonly collected in an Isaac-Kidd Midwater Trawl. This group consists of weak-swimming nekton such as mesopelagic fish, small squid, gelatinous organisms, and fish larvae.
MICROORGANISMS	Microscopic organisms, including bacteria, protozoans, yeast, viruses, and algae.
MICROZOOPLANKTON	Planktonic animals with lengths between 20 and 200 microns, composed mainly of protozoans and juvenile copepods.

MIXED LAYER	The upper layer of the ocean which is well mixed by wind and wave activity. Within this layer temperature, salinity, and nutrient concentration values are essentially homogeneous with depth.
NANNOPLANKTON	Minute planktonic plants and animals which are 50 microns or less in size and include algae, bacteria and protozoans. Individuals of this size will pass through most nets and are usually collected in centrifuges.
NEAR-FIELD	The near-field region is that region in which the plume momentum is the dominant factor, controling entrainment and mixing of the plume with the ambient receiving waters.
NEKTON	Free-swimming aquatic animals, essentially moving independent of water movements.
NEUSTON	A community of minute organisms which are associated with the surface film of water; mainly composed of pontellid copepods and the eggs and larvae of fish.
NUTRIENT	Any substance which promotes growth or provides energy for biological processes.
NUTRIENT-LIGHT REGIME	The overall condition of the nutrients and light in the environment in relation to photosynthesis.
ONE PERCENT LIGHT DEPTH	The depth at which light has been attenuated to 1 percent of its surface value; used to define the photic zone; that depth above which net productivity of phytoplankton may occur.
OPEN CYCLE SYSTEM	A powerplant system in which the coolant and/or working fluid passes through the plant only once and is then discharged.
OPERATING CONDITIONS	The maximum value of winds, waves, or currents below which OTEC-1 is able to operate.
ORTHO-PHOSPHATE	One of the possible salts of orthophosphoric acid; one of the components in seawater of fundamental importance to the growth of marine phytoplankton.
OTEC	Ocean Thermal Energy Conversion.
OTEC-1	The 1 megawatt test platform which will test the ocean thermal energy conversion cencept.
OXIDATION	The combination of a substance with oxygen. A reaction in which the atoms in an element lose electrons and its valence is correspondingly increased. Examples of oxidation are the rusting of iron, the burning of wood in air, the change from cider to vinegar, and the decay of animal and plant material.

OXYGEN MINIMUM LAYER	The portion of the water column in which the lowest concentration of dissolved oxygen exists.
PARAMETERS	Any of a set of arbitrary physical properties whose values determine the characteristics or behavior of something, e.g., temperature, pressure and density; a characteristic element.
PELAGIC	Pertaining to the open sea or organisms not associated with the bottom.
pH	The acidity or alkalinity of a solution as determined by the negative logarithm of the hydrogen ion concentration.
PHOTIC ZONE	The layer of the ocean from the surface to the depth where light has been attenuated to 1.0 percent of the surface value. The zone in which primary production shows a net increase.
PHOTOSYNTHESIS	Synthesis of chemical compounds in light, especially the manufacture of organic compounds from carbon dioxide and a hydrogen source, with simultaneous liberation of oxygen by chlorophyll-containing plant cells.
PHYTOPLANKTON	Minute passively floating plant life of a body of water; the base of the food chain in the sea.
PLANKTON	Organisms whose movements are determined by the currents and not by their own locomotive abilities.
PRIMARY PRODUCTION	The amount of organic matter synthesized by organisms from inorganic substances in unit time, in a unit volume of water, or in a column of water of unit area extending from the surface to the bottom.
RECRUITMENT	Addition to the population by reproduction of new individuals.
SALINITY	The amount of dissolved salts in seawater measured in grams per kilogram, or parts per thousand.
SPECIES	(1) A group of organisms having similar characteristics and capable of interbreeding and producing viable offspring; (2) A taxon forming basic taxonomic groups which closely resemble each other structurally and physiologically and in nature, interbreed and produce fertile offspring.
SPECIFIC GRAVITY	The ratio of the density of substance relative to the density of pure water at 4°C.

STANDING STOCK	The biomass or abundance of living material per unit volume or area of water.
STRESSED	A state caused by factors which tend to alter an existent equilibrium, or normal state.
SUSPENDED SOLIDS	Finely divided particles of a solid temporarily suspended in a liquid, such as soil particles in water, expressed as a weight per unit volume.
TERRIGENOUS	Being or relating to oceanic sediment derived directly from the destruction of rocks on the Earth's surface.
THERMAL EFFICIENCY	The ratio of the work done by a heat engine to the heat energy absorbed by it.
THERMOCLINE	The region of the water column where temperature changes most rapidly with depth.
TOTAL RESIDUAL CHLORINE (TRC)	The summation of the chlorine concentrations in various compounds in water, including hypochlorous acid hypochlorite ion, chloramines, and other chloro derivitives.
TRACE CONSTITUENT	An element or compound found in the environment in extremely small quantities.
TROPHIC LEVELS	Any of the feeding levels through which the passage of energy of an ecosystem proceeds. Typical marine trophic levels include: phytoplankton, zooplankton, and fish.
TURBIDITY	A reduction in transparency, as in the case of seawater, by suspended sediments or plankton.
UPWELLING	The rising of water toward the surface from subsurface layers of a body of water. Upwelling is most prominent where persistent wind blows parallel to a coastline so that the resultant wind current sets away from the coast. The upwelled water, besides being cooler, is rich in nutrients, so that regions of upwelling are generally areas of rich fisheries.
WARM WATER PIPE	That component of the OTEC plant through which the warm, surface water used to vaporize the working fluid is drawn.
WATER MASS	A body of water usually identified by its temperature-salinity (T-S) curve or its chemical content.
WORKING FLUID	The medium in an OTEC plant which is vaporized by warm ocean water, passed over a turbine to generate electricity, and finally condensed by cool ocean water to be recirculated through the closed system.

ZOOPLANKTON	The passively floating or weakly swimming animals of an aquatic ecosystem.

APPENDIX D
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