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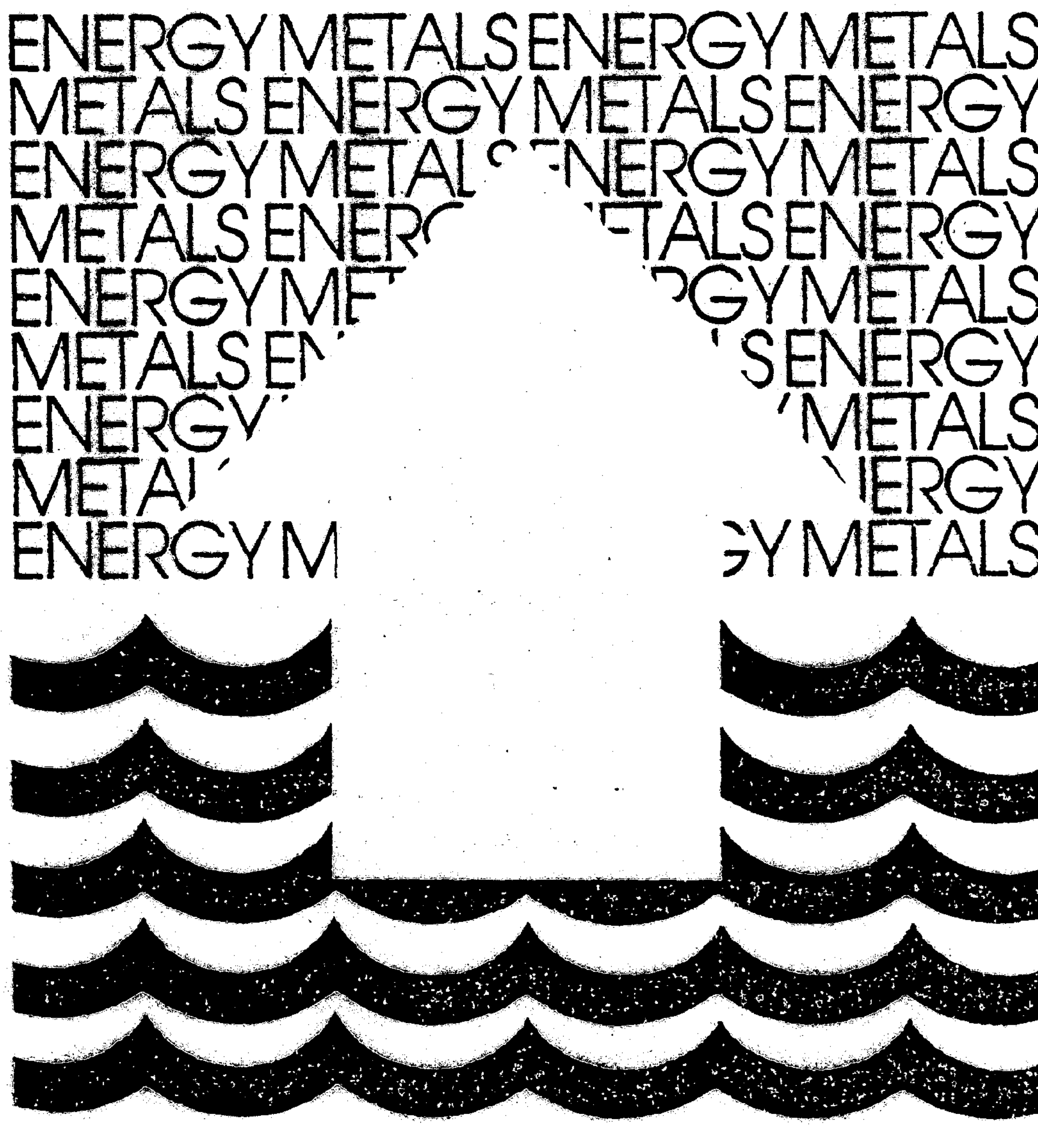

Ocean Thermal Energy Conversion

Technical Support Document

DRAFT

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Office of Ocean Minerals and Energy
May 1981

1608201.

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

OFFICE OF THE ADMINISTRATOR

OME:EPM

Dear Reviewer:

Enclosed is the draft Technical Support Document (TSD) for the environmental aspects of the regulations for licensing commercial OTEC operations (15 CFR Part 1001). The purpose of the TSD in its final form, will be to provide guidance on preparing the environmental portion of an application for an OTEC license.

A 30-day period, from June 1 to June 30, 1981, has been established for public review and comment on the draft TSD. Additionally, a workshop on the document will be held from 9:00 a.m. to 12 noon, Friday, June 12, 1981, in Room 6802, Department of Commerce Building, located at 14th Street between Pennsylvania and Constitution Avenues, N.W., Washington, D.C.

The purpose of the comment period and the workshop is to improve the TSD. Thus NOAA is interested in additional considerations, techniques, references, etc., as well as comments on the overall philosophy of the document. It is hoped that reviewers will be able to provide written or graphical material to support suggested changes or additions. This will allow for more efficient reworking of the draft document.

I look forward to your comments and your active participation at the workshop. Written comments may be submitted directly to:

Robert W. Knecht, Director
Office of Ocean Minerals and Energy
Page 1 Building, Room 410
2001 Wisconsin Avenue, N.W.
Washington, D.C. 20235

Sincerely,

RWKnecht

Robert W. Knecht
Director
Office of Ocean Minerals and Energy

Enclosure

Proposed Rules

Federal Register
Vol. 46, No. 97
Wednesday, May 20, 1981

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

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

15 CFR Part 1001

Availability, Public Comment Period, and Workshop on Technical Support Document for the Environmental Requirements Under the Regulations for Licensing Ocean Thermal Energy Conversion (OTEC) Facilities and Plantships

AGENCY: National Oceanic and Atmospheric Administration, Commerce.

ACTION: Notice of availability, public comment period, and workshop on technical support document.

SUMMARY: Pub. L. 96-320, the Ocean Thermal Energy Conversion Act of 1980 ("the Act") is intended to provide a stable legal system and streamlined licensing process to facilitate development of ocean thermal energy conversion (OTEC) facilities and plantships. The National Oceanic and Atmospheric Administration (NOAA) has lead responsibility for implementing the Act and has issued proposed regulations for comment (46 FR 19418, March 30, 1981). Among other things, the proposed regulations require an applicant for an OTEC license to prepare an environmental assessment of potential affects of OTEC operations (§ 1001.260). NOAA has prepared a draft Technical Support Document (TSD) that is intended to provide guidance on the types of specific information and analyses an applicant might wish to provide to satisfy this requirement. This notice announces the availability of the draft TSD, a public comment period and a workshop on the document. Interested persons are invited to request a copy of the draft TSD and to participate in its refinement.

DATES: (1) In order to allow NOAA time to consider comments and prepare a final TSD by the time of issuance of the final OTEC regulations, public comments on the draft TSD should be submitted by June 30, 1981.

(2) NOAA will hold a workshop to discuss issues identified in the draft TSD and to improve its content on Friday, June 12, 1981, between 9:00 a.m. and 12 noon.

ADDRESSES: (1) Requests for copies of the draft TSD should be directed to the Office of Ocean Minerals and Energy, NOAA, Page 1 Building, Room 410, 2001 Wisconsin Avenue, N.W., Washington, D.C. 20235 (telephone 202-254-3483).

(2) Written comments on the draft TSD should be directed to Robert W. Knecht, Director, Office of Ocean Minerals and Energy (address above).

(3) The location of the June 12 public workshop on the draft TSD will be Room 6802, Department of Commerce Building, 14th Street between Pennsylvania and Constitution Avenues, N.W., Washington, D.C.

FOR FURTHER INFORMATION CONTACT: Richard Norling or Edward P. Myers, Office of Ocean Minerals and Energy, NOAA, Telephone: 202-254-3483.

Dated: May 14, 1981.

Francis J. Balint,

Acting Director, Office of Management and Computer Systems.

[FR Doc. 81-15039 Filed 5-19-81; 8:45 am]
BILLING CODE 3510-12-M

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Technical Support Document
for
Commercial OTEC Licensing Regulations
15 CFR Part 1001

1. INTRODUCTION

The OTEC Act of 1980, P.L. 96-320, (the Act) calls for the establishment of a legal regime to reduce the legal and regulatory barriers to construction of commercial OTEC facilities and plantships. The principle goals of the legislatively-mandated licensing system to be administered by NOAA are:

1. to permit and encourage development of OTEC as a commercial energy technology;
2. to ensure that one OTEC plant does not interfere with the ocean thermal resource used by another OTEC plant, or adversely affect the territorial sea or area of the recognized area of national resource jurisdiction of another nation;
3. to protect the marine and coastal environment; and
4. to ensure that commercial OTEC facilities and plantships licensed by NOAA will be operated with reasonable regard for the exercise, by United States citizens and foreign nationals, of recognized freedoms of the high seas.

NOAA has considered four general approaches to licensing regulations: (1) detailed regulation of OTEC activities, (2) moderate regulation of OTEC activities, (3) minimum regulation of OTEC activities, and (4) no regulations. The advantages and disadvantages of these approaches are discussed in the Environmental Impact Statement for Commercial Ocean Thermal Energy Conversion (OTEC) Licensing (NOAA, 1981a), and in greater detail in the Regulatory Impact Analysis on implementing the OTEC Act (NOAA, 1981b). NOAA's chosen approach is that of minimal regulation since it offers the greatest encouragement for creation of a commercial OTEC industry and the maximum flexibility for addressing site-specific environmental characteristics and effects. This approach is further considered to provide the most cost-effective protection of the environment.

Under this approach, detailed guidelines and performance standards are not prescribed in advance, but are included in the terms and conditions of a license if they are deemed necessary to prevent significant adverse impacts on the environment or to prevent other results contrary to the law. The use of license terms and conditions, rather than uniform regulations, to address significant problem areas requires NOAA to examine each applicant's assessments of the nature and relative magnitude of each type of problem that might occur. Additionally, NOAA must develop and publish an environmental impact assessment for each OTEC application. An application for a permit to construct and operate an OTEC plant thus must contain sufficient information for judging the environmental risks and possible alternatives for risk aversion, and for NOAA to use in preparing the consolidated environmental impact statement required by the Act.

This Technical Support Document represents NOAA's suggested guidance on preparing the environmental portion of an application for an OTEC license to be submitted under 15 CFR Part 1001, Licensing of Ocean Thermal Energy Conversion Facilities and Plantships. It is by no means definitive; thus, if an applicant believes another approach is more appropriate for presenting the environmental aspects of an OTEC application, the applicant should use the alternative approach. In any case, potential applicants are encouraged to avail themselves of the pre-application consultation provisions of the OTEC regulations, 15 CFR §1001.70.

1.1 GENERAL REQUIREMENTS

To ensure that the environmental information included in an OTEC application will be relevant and in sufficient detail for making judgments regarding environmental risk, it is prerequisite to know what questions are going to be asked and to what use will be made of the information. This section and the next are presented in this spirit, for it is all too often that such information is collected with little regard to the actual decisions that will be made.

1.1.1 Requirements of the OTEC Act.

Section 107 of the Act requires the Administrator (NOAA) to initiate a program to assess:

"(1) any short-term and long 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 and magnitude of any oceanographic, atmospheric, weather, climatic, or biological changes in the environment 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."

Furthermore, the Act states that "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" (NEPA). The Administrator is required to prepare a single environmental impact statement (EIS) fulfilling the requirements of all Federal agencies in carrying out their responsibilities under the Act, for each OTEC facility or plantship application. Furthermore, §107(e) of the Act requires the draft EIS (DEIS) to be prepared within 180 days after notice of the initial application has been published.

Section 110 of the Act requires each licensee "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". In this regard, NOAA's proposed regulations would require an applicant to provide a description of a monitoring program to demonstrate compliance with applicable water quality standards, to provide for early detection of potential release of pollutants from OTEC operations, and to monitor the effects of OTEC discharges on water, sediment, and biological quality, 15 CFR 1001.260(a)(12)

1.1.2 Existing Regulatory Requirements.

In deciding on the minimal regulation approach, NOAA concluded that existing environmental protection statutes and regulations provide a relatively comprehensive framework for controlling OTEC environmental effects. In particular, EPA's NPDES program, and the Ocean Discharge Criteria established by EPA under Section 403(c) of the Clean Water Act, provide a rational set of criteria for evaluating OTEC environmental impacts and establishing an appropriate mix of discharge conditions and monitoring requirements to assure that no unreasonable degradation of the marine environment occurs as a result of OTEC operations.

1.1.2.1 Clean Water Act. Section 301 of the Federal Water Pollution Control Act (as amended, the Clean Water Act, 33 U.S.C. 466 *et seq.*) prohibits the discharge of any pollutants without a NPDES permit or in violation of the terms and conditions of a NPDES permit. NPDES permits contain technology-based effluent limitations, or limitations to meet the water quality standards of the receiving waters, or other more stringent State requirements.

The Ocean Discharge Criteria (45 FR 65942; October 3, 1980) implement Section 403(c) of the Clean Water Act which calls for guidelines for determining the degradation of the waters of the territorial seas, the contiguous zone, and the ocean. The Ocean Discharge Criteria allow the Administrator of the U.S. Environmental Protection Agency (EPA) to issue an NPDES permit for a discharge to such waters if, on the basis of available information, the discharge will not cause "unreasonable degradation" of the marine environment. Such a determination is based on:

(1) The quantities, composition, and potential for bioaccumulation or persistence of the pollutants to be discharged (15 CFR §1001.260(a)(2)).

(2) The potential transport of such pollutants by biological, physical, or chemical processes (15 CFR §1001.260(a)(3)).

(3) The composition and vulnerability of the biological communities which may be exposed to such pollutants, including the presence of unique species or communities of species, the presence of species identified as endangered or threatened pursuant to the Endangered Species Act, or the presence of those species critical to the structure or function of the ecosystem such as those important for the food chain (15 CFR 1001.260(a)(4)).

(4) The importance of the receiving water area to the surrounding biological community, including the presence of spawning sites, nursery/forage areas, migratory pathways, or areas necessary for other functions or critical stages in the life cycle of an organism (15 CFR §1001.260(a)(6)).

(5) The existence of special aquatic sites including, but not limited to marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas, and coral reefs (15 CFR §1001.260(a)(7)).

(6) The potential impacts on human health through direct and indirect pathways (15 CFR §1001.260(a)(5)).

(7) Existing or potential recreational and commercial fishing, including finfishing and shellfishing (15 CFR §1001.260(a)(8)).

(8) Any applicable requirements of an approved Coastal Zone Management plan (15 CFR §1001.210(g))

(9) Such other factors relating to the effects of the discharge as may be appropriate (15 CFR §1001.260(b)).

(10) Marine water quality criteria developed pursuant to Section 304(a)(1) of the Clean Water Act (15 CFR §1001.210(b)).

Because an OTEC facility or plantship will require an NPDES permit, NOAA has included in the regulations a requirement for the applicant to submit information on these criteria. The EPA will use that information in developing the required NPDES permit. Citations following the above factors are to the section of NOAA's regulations which require that information.

Section 311 of the Clean Water Act creates liability for the discharge of oil or hazardous substances and provides for prevention and control of spills of oil and hazardous materials when they occur. With regard to the activities under P.L. 96-320, the potential exists for such spills to occur at sea. Action for spill prevention and control would be under the purview of either EPA or the Coast Guard, depending upon the nature of the activities being carried out at the facility. Spills from the operations of OTEC facilities or plantships under P.L. 96-320 could be expected to result from vessel collisions, industrial accidents or spills of anti-fouling chemicals, working fluids, or materials produced at the facility or plantship.

1.1.2.2 Clean Air Act. The Clean Air Act may also have some relevance to the licensing of OTEC facilities; particularly if there were to be emissions associated with production of energy intensive products (e.g., ammonia and aluminum) powered by the energy derived from the thermal conversion process. Under Section 111 and 112 of the Clean Air Act, the EPA Administrator has promulgated emission standards for new stationary sources of air pollution and emission standards for hazardous air pollutants (CFR). These standards may be applicable to OTEC facilities and plantships which are discharging pollutants into the air from an on-site refining or manufacturing process powered energy.

In accordance with Section 161(g) of the Clean Air Act, the EPA Administrator has promulgated regulations which require States to adopt plans for the prevention of significant deterioration (PSD) of air quality (CFR). In the absence of an approved State plan, EPA must ensure that air emissions from new sources will be in conformance with PSD requirements. The possibility exists that OTEC facilities operating within a State's three-mile limit and discharging pollutants into the atmosphere may require a State, or EPA PSD permit.

If air emissions from an OTEC facility located in one State may have an adverse impact on the air quality in an adjacent State, special notification requirements must be met under Section 126 of the Clear Air Act. The EPA Administrator would be authorized to bring such a facility into compliance with emission limitations to prevent a violation of national ambient air quality standards in any adjacent State.

1.1.3 Other Provisions

To qualify for issuance of an OTEC license, an applicant will also have to show compliance with other pertinent Federal, State, and local environmental requirements, 15 CFR §§1001.210 and 1001.470(a)(1). These include, but may not be limited to:

- o Endangered Species Act
- o Marine Protection, Research and Sanctuaries Act
- o Marine Mammal Protection Act
- o Coastal Zone Management Act
- o Fish and Wildlife Coordination Act

The Endangered Species Act (16 USC 1531 et seq.) empowers the Secretary of Interior to list threatened and endangered species, according to certain criteria and in some cases according to the determination of the Secretary of Commerce. The taking of any such species, whether it be upon the high seas or the territorial seas or within the United States, is prohibited, subject to certain exceptions. A taking can be the harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, or collecting, or any attempt to do such.

Title I of the Marine Protection, Research and Sanctuaries Act (33 U.S.C. §1401 et seq.) prohibits the transportation of materials from U.S. ports for dumping anywhere on the high seas or the dumping of any materials into the U.S. territorial seas or contiguous zone, without an appropriate Federal permit. "Dumping" is defined as the dispostion of any material, except for disposition of effluent from an outfall regulated under the Clean Water Act, routine vessel effluent discharges, and several other narrow exceptions. In the case of dredged material, the Secretary of the Army is the permitting authority, and other authorized materials may be disposed of in a place designated in a permit granted by the Administrator of the EPA. Title III (16 U.S.C. 1431 et seq.) authorizes the Secretary of Commerce, with the approval of the President, to designate as marine sanctuaries, areas of ocean waters as far seaward as the edge of the Continental Shelf and coastal waters of the oceans (and of the Great Lakes). Additionally, he may issue regulations to "control any activities permitted" within such marine sanctuaries. An OTEC license, in order to be issued for activities within a designated marine sanctuary must be certified by the Secretary of Commerce to be consistent with the "purposes of this Title" and would have to be carried out within the above mentioned regulations, §302(f).

The Marine Mammal Protection Act (16 U.S.C. 1361 et seq.) imposes a prohibition against the taking or importation of marine mammals, subject to certain exceptions and permits. A taking includes the harrassment of marine mammals and the prohibition applies to persons and vessels and other means of conveyance. Additionally, the term taking includes any attempts to harrass (or hunt, capture, or kill). The Act is administered by the Secretary of Commerce with respect to whales, porpoises, seals and sea lions, and by the

Secretary of Interior for sea otters, walruses, manatees, and polar bears. Both Secretaries may issue regulations and grant permits for exemptions from the prohibition. Among the activities explicitly authorized to be regulated and permitted is scientific studying (e.g., biotic sampling).

Section 307(c)(3) of the Coastal Zone Management Act (16 USC 1451 et seq.), prohibits a Federal agency from granting any license or permit to conduct an activity "affecting land and water uses in the coastal zone" of any State having an approved State coastal zone management program over the objection of that State. The State's objection must be based on the activity being inconsistent with its approved program. The Secretary of Commerce may find, over the State's objection, that the activity is consistent with such program or that the activity is necessary in the interest of national security.

The Fish and Wildlife Coordination Act (16 USC 661-667e) requires in section 662 that, "...whenever the waters of any stream or body of water are proposed or authorized to be impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose whatever, including navigation and drainage, by any department or agency of the United States, or by any public or private agency under Federal permit or license, such department or agency first shall consult with the United States Fish and Wildlife Service, Department of the Interior, and with the head of the agency exercising administration over the wildlife resources of the particular State ...with a view to the conservation of wildlife resources by preventing loss of and damage to such resources as well as providing for the development and improvement thereof..." Under Reorganization Plan No. 4 of 1970, similar responsibilities under the Fish and Wildlife Coordination Act for marine, estuarine and anadromous fishery resources and certain classes of marine mammals are administered by the National Marine Fisheries Service of the

National Oceanic and Atmospheric Administration, Department of Commerce. Wildlife and wildlife resources are defined by the Act to include: "birds, fishes, mammals, and all other classes of wild animals and all types of aquatic and land vegetation upon which wildlife is dependent." Prior consultation and coordination by a potential permittee with the National Marine Fisheries, the Fish and Wildlife Service, and State fish and game agencies is strongly encouraged during the project planning and formulation stage. This is considered essential to "orderly" development of the project and to avoid unnecessary delays in project authorization.

The above potential requirements and some others that may have pertinence to commercial OTEC development are summarized in Table 1.

1.2 KEY CONSIDERATIONS

The preceding discussion provides a general basis for defining the types of environmental information that are desirable in an OTEC application. NOAA and other involved Federal agencies will use this information to prepare the single EIS on the application and to make judgments regarding the potential environmental risk. With the information provided by the applicant, and with due consideration to other relevant known information, NOAA will ask the following questions to assess the degree of environmental risk:

1. What are the potential adverse effects, if any, and what are their probabilities?

2. What are the potential beneficial effects and what are their probabilities?

3. What are the social and economic costs (consequences), and their significance, of both the adverse and beneficial events.

4. What alternative strategies might improve the ratio of benefits to costs?

Table 1. SUMMARY OF ENVIRONMENTAL IMPACTS WHICH CAN BE AVOIDED AND MAJOR RELEVANT FEDERAL LEGISLATION AND PERMITS

POTENTIAL ENVIRONMENTAL IMPACTS	AVOIDANCE/MITIGATION STRATEGIES	RELEVANT FEDERAL LEGISLATION/AUTHORITY			AGENCY
		STATUTE	REGULATIONS	REQUIREMENT	
1. Deposition of dredged or fil material in waters of the United States and contiguous wetlands	Utilize upland disposal areas, contain spoil	Clean Water Act (33 U.S.C. 1344)	33 C.F.R. 323	Minimize deposition in wetlands and waters	COE/ EPA/ States
2. Interference with federally designated Marine Sanctuaries	Avoid existing or potential Marine Sanctuaries	Marine Protection- Research and Sanctuaries Act of 1972 (16 U.S.C. 1432-1433)	15 C.F.R. 922	Preserve and protect Marine Sanctuaries	DOC
3. Interference with state designated Estuarine Sanctuaries	Avoid existing or potential Estuarine Sanctuaries	Coastal Zone Management Act of 1972 (16 U.S.C. 1461)	15 C.F.R. 921	Preserve and protect Estuarine Sanctuaries	DOC/ States
4. Interference with historical and/or archaeological sites, structures, or objects	Perform adequate historic and archeologic surveys, avoid designated sites and structures	National Historic Preservation Act (16 U.S.C. 470f) Preservation of Historical & Archaeological Data Act (16 U.S.C. 469-469b). Exec. Order No 11593	36 C.F.R. 800 36 C.F.R. 800	Review by state and Federal officials to preserve and protect historic and archaeologic sites	State/ACHP all fed. agencies
5. Jeopardizing existence of endangered or threatened species or adversely modifying their habitats	Perform adequate biological surveys, avoid endangered species habitats	Endangered Species Act (16 U.S.C. 1531-1541)	50 C.F.R. 17 50 C.F.R. 222, 226, 227 50 C.F.R. 402	Review to protect endangered and threatened species	FWS/ NMFS/ States
6. Harassment or "incidental taking" of marine mammals	Perform adequate biological surveys, avoid critical areas	Marine Mammal Protection Act (16 U.S.C. 1361-1382)	50 C.F.R. 18 50 C.F.R. 215-225	Protect marine mammals	FWS/ NMFS/ States?
7. Increased risk of loss from or damage by flooding	Locate structures outside flood hazard areas	Exec. Ord. No 11514 Exec. Ord. No 11988	-- --	No practicable alternative to encroaching on flood plain	all fed. agencies

Table 1 (cont) SUMMARY OF ENVIRONMENTAL IMPACTS WHICH CAN BE AVOIDED AND MAJOR RELEVANT FEDERAL LEGISLATION AND PERMITS

POTENTIAL ENVIRONMENTAL IMPACTS	AVOIDANCE/MITIGATION STRATEGIES	RELEVANT FEDERAL LEGISLATION/AUTHORITY			AGENCY
		STATUTE	REGULATIONS	REQUIREMENT	
8. Destruction or modification of wetlands	Locate all development outside wetlands	Exec. Ord. No. 11990	--	Minimize effect on wetlands	all fed. agencies
9. Conflict with designated Wilderness Areas	Locate away from designated Wilderness Areas	Wilderness Act (16 U.S.C. 1131-1135)	43 C.F.R. 19 36 C.F.R. 293 50 C.F.R. 35	Protect and preserve Wilderness Areas	DOI
10. Conflict with designated Wild or Scenic Rivers	Locate away from designated Wild or Scenic Rivers	Wild and Scenic River Act (16 U.S.C. 1271-1286)		Protect and preserve Wild and Scenic Rivers	DOI
11. Conflict with Prime and Unique Farmland	Avoid areas of designated Prime or Unique Farmland	16 U.S.C. 590 a-f	7 C.F.R. 657	Protect Prime and Unique Farmland	USDA
12. Release of toxic or hazardous materials as a result of flood tsunami, hurricane, or seismic activity	Avoid natural hazard areas	Clean Water Act 33 U.S.C. 1321 (c)(2)	40 C.F.R. 1510	Oil and hazardous substances spill contingency planning	EPA/CG

* The reader should note that the following are subject to the EPA consolidated permit program 40 C.F.R. 122-125, 45 F.R. 33287-33558 (May 19, 1980)

- Resource Conservation and Recovery Act (Hazardous Waste Management Program)
- Safe Drinking Water Act (Underground Injection Control Program)
- Clean Water Act (National Pollutant Discharge Elimination System and Dredge and Fill Programs)
- Clean Air Act (Prevention of Significant Deterioration Program)

The Clean Water Act and other requirements discussed above will be factored into the analysis, along with the requirements of the National Environmental Policy Act (NEPA) process. The Council on Environmental Quality's regulations that implement NEPA (40 CFR Parts 1500 through 1508) requires and assessment of the following:

- The proposed action
- The reasonable alternatives including the proposed action
- The affected environment
- The environmental consequences of the proposed and alternative actions

According to the NEPA regulations, the discussion of environmental consequences must include the environmental impacts of the alternatives including the proposed action, any adverse environmental effects which cannot be avoided, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented. Furthermore this portion of the analysis must include discussions of:

- Direct effects and their significance
- Indirect effects and their significance
- Possible conflicts between the proposed action and the objectives of Federal, regional, State, and local land use plans, policies and controls for the area concerned
- Energy requirements and conservation potential of various alternatives and mitigation measures

- Natural or depletable resource requirements and conservation potential of various alternatives and mitigation measures

- Urban quality, historic and cultural resources, and the design of the built environment, including the re-use and conservation potential of various alternatives and mitigation measures

- Potential means to mitigate adverse environmental impacts

These key considerations are discussed below with an emphasis on the controlling variables and the informational needs. The discussions are not meant to be all-inclusive; there may be other site-specific information that NOAA and/or the applicant will believe to be important to the environmental decisions to be made. In such situations the applicant should give careful consideration to the information needs of NOAA and the other involved Federal agencies. NOAA will cooperate with requests for help in this regard and applicants should avail themselves of the pre-application consultation opportunities noted earlier.

2. TECHNICAL GUIDANCE

This chapter of the Technical Support Document provides guidance on the types of environmental information which might be submitted with an OTEC application. It does so by first providing an environmental overview to illustrate the environmental parameters that will be influenced by an OTEC operation, and then describing in more detail the considerations associated with these parameters.

2.1 ENVIRONMENTAL OVERVIEW

OTEC structures will be either land based, with pipelines extending into coastal waters; moored or bottom-resting within the continental shelf region; or floating or propelled in the open ocean (NOAA, 1981a). If they are moored or bottom resting they will have large forces applied to them through the combined action of wind, currents, waves, and seismic activity. Although the design engineer must attempt to assure that the OTEC structure will survive such forces of nature, these attempts are not always successful, as has been shown by experience with oil-platforms in the Gulf of Mexico and elsewhere. In the event of an accident, one must ask what will be the consequences of either a sinking or drifting (out of countrol) OTEC facility. The consequences would depend upon the structure itself, oceanic and coastal currents, hazardous or other substances used or stored, and the other resources and uses of the region. Even without the intervention of nature, such disasters may occur as a result of collisions, particularly in areas where there is a high volume of tanker or submarine traffic.

The OTEC process relies upon extracting heat from the surface waters of ocean to produce power. It does so by using heated ocean waters to evaporate a working fluid (e.g., ammonia) in a closed-cycle process or seawater itself in an open-cycle process (see NOAA, 1981a). The vapor phase is passed through a turbine to produce power, and then condensed again in a heat exchanger exposed to deeper, colder waters pumped to the plant. If the process is closed-cycle, the working fluid is then pumped back across a heat exchanger exposed to warm ocean waters and thence to the turbine again. If the process is open-cycle, the condensate is freshwater and can be used as such or discharged.

Two additional aspects of the open-cycle process are noteworthy. First, only about 1-percent of the seawater will be evaporated; thus the residual salinity of the warm water discharge would be increased by only about 1-percent. For most environments, this variation will be within the tolerance levels of biota exposed to the discharge. Second, the seawater must be rid of dissolved gases before being flash evaporated;

thus, the discharge will have little or no dissolved oxygen content. Rapid dilution in the receiving waters should mitigate this problem; however, if not the case, this could pose some environmental problems.

The seawater flow-rate requirments for an OTEC plant will depend on the available thermal resource, heat exchanger and power system design. Based on a thermal resource of 22°C, conceptual designs indicate that flows on the order of 3.5-4.0 cubic meters per second per megawatt of net power generated will be required for both the warm and cold seawater systems. The total seawater flow rate of a 400-MW OTEC plant would thus be about 2800-3200 cubic meters per second. The warm seawater will be cooled by about 3°C and the cold water will be warmed by about the same amount during passage through the heat exchangers. The seawater will then be returned to the ocean through some sort of outfall system. Because of engineering design considerations, the velocity of the water at the point of discharge will probably not be very different from the velocity within the plant. Based on existing conceptual designs, the discharge velocity will probably be in the range of 1.7-2.4 meters per second (m/s), however discharge velocities as low as 1 m/s or as high as 4 m/s might be possible depending on the details of the outfall design.

It is obvious that any organisms inhabiting waters pumped through the warm water intake or the cold water intake will either: (1) be entrained and travel through the facility, (2) be impinged on screens designed to reduce the mass and size of entrained materials, or (3) manage to swim away and thus avoid these effects. Most probably, organisms entrained by the cold water intake will suffer 100 percent mortality due to the resulting large pressure changes. It is uncertain regarding what percentage might survive entrainment by the warm water intake. The impact of entrainment and impingement on overall biological productivity, particularly of commercially and recreational fisheries, is obviously a major concern.

One of two strategies may be employed after the two intake water streams have served their purpose: (1) they may be discharged separately, or (2) they may be discharged as a mix (combined). Although the choice may depend upon site-specific considerations, current thought leans toward the mixed discharge. In either event, and despite what depth the discharge(s) is (are) made, the effluents will initially seek an area somewhere near the bottom of the mixed layer at the pycnocline. The dilution achieved at this point will be due to entrainment of surrounding ambient waters along the effluent plume's trajectory (secondary entrainment for purposes of this document). Such secondary entrainment will result in the translocation (movement from one location to another) of biota that were not initially entrained at the intake structure.

The surface waters near most of the potential OTEC sites tend to be low in nutrients (oligotrophic); thus the biological harvest they provide to humans on a per unit area basis is also very low. The operation of OTEC plants may alter this if the deeper, nutrient rich waters are eventually dispersed to some degree into the surface waters after discharge. This could increase productivity several-fold having a positive effect on fisheries or it could possibly result in a eutrophic situation with resultant nuisance and ecological problems. Even when beneficial from the standpoint of fisheries, it could be detrimental aesthetically to water clarity and color.

In addition to biocides used to control biofouling in the heat exchangers, the release of potential pollutants such as metals from corrosion of piping and heat exchange material, working fluids due to leaks, or hull coating materials may have biological implications. Such substances may further be incorporated into the food chain and come to pose public health problems.

Because they do extract heat from the warm surface waters of the ocean, OTEC plants will be designed and located so as to ensure that this resource is not depleted so as to reduce their or another plant's efficiency. Under extensive development scenarios within defined geographic regions this will require assurances that the net rate at which heat is naturally added to the regional waters is equal to or greater than the rate at which it will be extracted by OTEC operations. NOAA will be conducting research on this problem in the future; however, it is not expected that this will be a near term problem.

The occurrence of an accident resulting in a release of pollutants to either the ocean or the atmosphere would pose added environmental risk to ocean resources and nearby human populations, respectively. The fate of such substances would depend upon their characteristics and potential transport pathways.

In addition to affecting the marine environment, OTEC construction and operation activities will have implications for the terrestrial environment. Such implications could relate to construction and operation of land-based plants, or the direct and indirect land-side activities that may be associated with an offshore OTEC plant. The magnitude of any disturbances will be determined by the proximity of ecologically-sensitive areas, the nature of the existing biological and physical environment, the design of the OTEC plant, the accessibility of the site, and the proximity of the site to the resources required for plant construction.

Commercial OTEC development will also have indirect effects that could be of either a positive or negative nature. The construction of OTEC components may require changes to existing shipyard facilities, the dredging of waterways, construction of new piers, etc. Most of the coastal states in which construction facilities are likely to be located have Federally-approved coastal zone management programs which influence the design and impacts of facilities constructed along the coast. These measures should ensure that unacceptable environmental impacts do not occur.

OTEC plant construction and operation should provide substantial socio-economic benefits. OTEC plant components will be manufactured at shipyards and industrial facilities in island communities and the continental United States, which will result in employment opportunities. The projected job impact of OTEC plant construction could be significant for large depressed city areas, where most shipyards are located. For example, it is estimated that 2,000 worker-years of shipyard employment would be required to construct a 40-MWe plantship (Francis et al., 1979).

2.2 INFORMATIONAL NEEDS

This discussion is organized according to the information requirements in the OTEC licensing regulations, 15 CFR Part 1001. Citations to the sections of the regulations requiring the type of information described here are given. A final section (Appendix B) references the data requirements for environmental design and operational criteria developed by the Department of Energy (DOE) for use in their OTEC pilot plant program. The information on the requirements is provided solely as background to aid a potential applicant in deciding upon the types of environmental information that it might wish to provide in an application for a commercial OTEC license. It is hoped that the organization of this section will aid the applicant in providing a "systems" assessment of all factors, leading to a description of environmental risk.

2.2.1 Environmental Information, 15 CFR §1001.260.

2.2.1.1 §1001.260(a)(1). This section of the OTEC regulations requires a description of the area or areas of the ocean in which the OTEC activities of the applicant might impact so as to significantly degrade the operation of another OTEC facility or plantship, and in which the potential operation of another OTEC facility or plantship might impact so as to significantly degrade the OTEC operation proposed by the applicant. Such impacts might occur as a result of either physical-chemical or biological changes within the water column, including the following:

- Reduction of temperatures of surface waters
- Reduction of the depth of the mixed layer
- Increase in factors leading to biofouling
- Increase in entrainment and impingement

The reduction of the temperature of surface waters could result directly from the extraction of heat from the surface layer at a rate that cannot be replenished by insolation or the advection of the heat contained in surrounding ambient waters. Such concerns might require estimates of regional heat balances to discern whether the extracted heat will indeed be replaced in local waters. Most probably, however, this will not pose a problem except at sites that may have restricted circulation and/or limited days of bright sunshine. For the most part, OTEC resource areas do not have these charactericstics.

A reduction of temperature in the surface waters surrounding an OTEC plant would most probably result from the dilution of these waters with OTEC warm water, cold water, or mixed discharges. Since all of these discharge types would be of a lower temperature than that of the surface intake waters, any mixing of the discharge waters into the surface layer could result in a diminished thermal resource. To assess this, consideration must be given to both the initial and subsequent fates of the discharge(s) (see 2.2.1.3 below).

A reduction in the temperature of warm waters pumped into an OTEC plant could also possible result from a reduction in the depth of the mixed layer. Under this scenario the pycnocline (and isotherms of lower temperature) would be drawn closer to the surface which, dependent upon the intake depth(s) of the plant(s), could jeopardize the needed intake temperature. Such a possibility is discussed in a report by the DOE (1980).

The available information on the factors that will influence the biofouling of OTEC heat exchangers is minimal. However, it is quite possible that the OTEC redistribution of waters of different chemistries and biologies may pose a threat to the efficient operation of another OTEC plant. Furthermore, the potential for increased productivity downstream of one plant could possibly result in increased entrainment/impingement at another plant which could hinder the operation of that plant.

Although much remains to be learned about such possiblilities, an OTEC applicant should consider the above types of factors in defining an area of influence as discussed under §1001.260(a)(1).

2.2.1.2 <u>§1001.260(a)(2)</u>. This requirement calls for consideration of the quantities, composition, and potential for bioaccumulation or persistence of the pollutants to be discharged. Such considerations are key to assessing the environmental risk of pollutants. Bioaccumulation is the process by which biota concentrate and accumulate certain pollutants to concentrations greater (often by many orders of magnitude) than those in the ambient water. Bioaccumulation can pose a public health threat because of direct ingestion of organisms that are responsible for the bioaccumulation, or ingestion of organisms that have been involved in the food chain transfer of pollutants that have been bioaccumulated. Bioconcentration results when the pollutant is further concentrated through the food chain after initial bioaccumulation. Some of the synthetic organics are known to bioaccumulate and bioconcentrate, whereas metals tend to bioaccumulate only.

Techniques for predicting the bioaccumulation of pollutants are discussed by Chiou et al. (1977), Leo et al. (1975), Metcalf (1977), and Neeley et al. (1974). Such techniques utilize the close correlation between the partitioning of the pollutant between n-octanol and water, with a stronger partioning in n-octanol indicating a stronger tendency to bioaccumulate.

The persistence of a pollutant relates to the seawater chemistry of the pollutant and to how long the pollutant remains in its chemical form before being changed to some other form by biological or chemical processes. Pollutants such as many of the synthetic organics are both toxic and persistent; this, coupled with bioaccumulation and bioconcentration tendencies, results in such pollutants posing high environmental risk.

2.2.1.3 <u>§1001.260(a)(3)</u>. Pollutants in the ocean environment may be transported by biological, physical, or chemical processes. Section 1001.260(a)(3) requires attention to these processes.

Biological transport is due to the bioaccumulation of pollutants (discussed above) and the subsequent transport from one location to another. The location transfer could result in the pollutant(s) being transferred from one medium to another (e.g., biota to air, water or sediments) or from one species to another (e.g., food chain transfer).

Physical transport of an OTEC discharge plume and contained pollutants will be governed by advective (movement by currents) and dispersive processes. Initially when the discharge enters the ocean, its density will be different from the immediate ambient ocean density. Buyoance (positive or negative) forces, due to this density difference, and the discharge velocity will primarily determine the initial fate of the discharge. The effluent will undergo significant mixing, resulting in initial dilutions being achieved in a matter of minutes, while achieving a level of neutral density. The region emcompassing the process of initial dilution can extend up to several hundred meters downstream from the point of discharge. Allender et al. (1978) may be referred to regarding the details and means of assessing this flow regime referred to as initial dilution.

After initial dilution, the discharge plume will drift with the ambient ocean current, spreading laterally and collapsing in the vertical due to residual buoyance forces. This region is referred to as the intermediate-field regime. The magnitude of the ambient current dominates the behavior of the plume in this regime, although local ambient density stratification and the initial dilution will have some influence on the width and thickness of the resultant plume (Ditmars, 1981). Very little additional dilution occurs in this regime. Jirka et al. (1980) have developed an analytical predictive model for the intermediate flow regime.

In the far-field region of the plume, the diluted effluent will be traveling at the same speed and have essentially the same density as the surrounding ambient ocean. The plume can therefore be treated analytically as completely passive. Additional mixing due to ambient turbulence is expected to be slow because of the inhibiting effect of the fairly strong ambient density stratification present in the vicinity of the thermocline where the effluent will be located. Several analytical models that treat far-field mixing as a diffusion-like process have been developed (Csanady, 1973, 1981; Brooks, 1960). In general these models require estimates for some sort of horizontal and vertical diffusion parameters. Precise values for these parameters are difficult to obtain but reasonable estimates can usually be found in the literature. Typically, such models predict that distances of several hundred kilometers corresponding to travel times of several days will be required to obtain additional dilution comparable to the original near-field dilution of 5-10.

The advective processes which play a major role in near, intermediate, and far-field processes can be quite complex to analyze and predict. They are dependent upon a number of variables including wind, waves, tides, the rotation of the earth, and density differences. These processes vary both spatially, vertically (in the water column), and temporarily. One means of delineating the relative roles of these types of factors is that of principal component analysis (Koh, 1977). Principal component analysis is a statistical technique that can be applied to a time-series of current data so as to achieve an understanding of causative factors and their relative roles. For instance, applying this technique to coastal currents offshore of San Francisco, Koh found the current data could be explained by three additive events: (1) a component due to tidal forces, (2) a component related to storms, and (3) a remaining component which was essentially random. The tidal component correlated very well with computed tidal currents at Golden Gate, implying that it could probably be predicted. The random component cannot be predicted, but could be simulated, and the storm component would have required further analysis to see if it could be predicted on the basis of weather and run-off conditions.

Chemical processes can modify the state and form of pollutants and thus modify their susceptibility to physical or biological transport processes. Pollutants discharged to the ocean can exist in the gaseous, dissolved, or particulate states. Pollutants in the dissolved state will eventually reach the atmosphere unless their state changes. Dissolved pollutants will be subject to the advective and dispersive processes of the oceans, but can also change states by being incorporated into the gaseous state or assimilated by biota. Particulate pollutants usually find their way to the seabed or are ingested by biota.

A good discussion of the chemical processes that will determine the state and chemical activity of pollutants in the ocean is that of Morel (1980). Although the emphasis is on municipal pollutants in coastal waters, the mechanisms are the same as those related to OTEC discharged pollutants.

2.2.1.4 <u>§§1001.260(a)4, (a)(7), and (a)(8)</u>. These sections require information relative to the biological communities which may be exposed to OTEC discharges. Section 1001.260(a)(4) asks for an assessment of the composition and vulnerablility of the biological communities which may be exposed to such pollutants, including the presence of unique species or communities of species, the presence of species identified as endangered or threatened pursuant to the Endangered Species Act, or the presence of those species critical to the structure or function of the ecosystem, such as those important for the food chain. Section 1001.260 (a)(6) addresses the importance of the receiving water area to the surrounding biological community, including the presence of spawning sites, nursery/forage areas, migratory pathways, or areas necessary for other functions on critical stages in the special aquatic sites including but not limited to marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas, and coral reefs. Section 1001.260(a)(7) requires identification of special aquatic sites which might be significantly impacted by the proposed OTEC operations including, but not limited to estuarine or marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas and coral reefs. Section 1001.260(a)(8) relates to existing or potential recreational and commercial fishing, including finfishing and shellfishing.

Numerous biological parameters will be of interest in assessing the potential impacts of an OTEC plant on biological communities. The following particular discussion draws from pertinent sections of the Technical Support Document for the regulation promulgated pursuant to Section 301(h) of the Clean Water Act (EPA, 1979).

The spatial distributions of distictive habitats and of commercial or recreational fishery species is a special concern. Structural characteristics of the communities present (multispecies assemblages) generally provide good evidence of impacts. These include species composition and abundance, as indicated by either the density of biomass or of individual species, richness of species, dominance, or spatial stratification particularly along depth contours if the waters are relatively shallow. Later, in the operational mode, the monitoring of alterations in community structure and population dynamics should be interpreted in relation to the functional characteristics of the marine ecosystem including changes in dominant trophic levels, productivity at primary and higher levels, and especially the yield of commercial and recreational fisheries.

The documentation supplied in response to §§1001.260(a)(4), (a)(6), and (a)(7) should reflect an understanding of the quality and quantity of the discharge and the sensitivity of the receiving environment. Such information will eventually be evaluated on the basis of the quality of the information provided, including the adequacy of sampling designs, statistical analyses and species identifications. Sampling guidelines for demersal, benthic, planktonic, and intertidal marine communities are available from EPA (Mearns et al., 1978 Swartz, 1978; Jacobs et al., 1978; Stofan et al., 1978; Gonor et al., 1978), though other methods may be acceptable. Boesch (1977) reviewed a variety of techniques for examining spatial heterogeneity in species composition, density, and diversity. These publications are suggested only as a guide to the kind of quantitative biological analyses that could be provided in an OTEC application. Applicants should provide only those analyses which are warranted in individual cases, but should provide a rationale for the design and extent of their biological assessment.

Distinctive habitats of limited distribution include those segments of the marine environment whose protection is of special concern because of their ecological significance or direct value to humans. These include, but are not limited to, coral reefs, kelp beds, sea grass meadows, intertidal or subtidal rock outcroppings, other sites of concentrated productive fisheries and all areas officially recognized as marine or estuarine sanctuaries.

Applicants should further consider the presence and distribution of fishery stocks (molluscan, epibenthic crustacean, demersal and pelagic fisheries) that could be influenced by OTEC operations. Potential impacts might further be analyzed in relation to the market acceptability or condition of commercially or recreational fisheries. Market acceptability would be influenced by the bioaccumulation of toxicants, presence of human pathogens, and the physical (aesthetic) conditions of the fish. Impacts, if any, of OTEC operation on local fisheries might appear in comparisons of catch records, changes in size frequency, attraction or repulsion of biota to the structure, the distribution of fishing, breeding and spawning grounds, migratory pathways, and other factors that may effect fishery productivity.

2.2.1.5 §1001.260(a)(5). This section of the OTEC regulations addresses the potential impacts on human health through direct and indirect pathways. The concern over the transfer to humans of either pathogenic organisms or toxicants has been heightened by significant environmental crises during the last decade or so. Such contaminants can reach humans through direct contact, inhalation, or ingestion. Although the risk due to direct contact or inhalation is relatively low, that due to ingestion, particularly of contaminated seafood can be substantial. Bioaccumulation of such toxicants and their food chain transfer intensifies this concern.

An OTEC applicant should give consideration to the contaminants that could reach humans and pose a public health risk. Probably the best means of doing so is to use the assessments of physical and biological transport discussed under §1001.260(a)(3) to estimate the concentrations that may occur in the environment. This information should then be coupled with knowledge regarding potential bioaccumulation and food chain links in order to estimate concentrations in edible species. An assessment of critical pathways is valuable in this regard (Foster et al., 1971).

The critical pathways approach was developed to assess the human health risk associated with discharging low-level radioactive wastes to marine waters. It is assumed that there are one or two contaminant pathways, of numerous possibilities, that pose the most risk. In addition, special consideration is given to certain population types (pregnant women, children, etc.) that may be the most prone to risk.

An OTEC applicant should give particular attention to any toxic pollutant listed on EPA's list of toxic pollutants and pesticides (Appendix A), which may be present in the OTEC discharge or which might be released through an accident.

2.2.1.6 <u>§1001.260(a)(9) and §1001.260(a)(10)</u>. These sections of the regulations require descriptions of natural meteorological and seismological conditions that could influence an OTEC operation and have environmental implications. §1001.260(a)(9) requires a description of expected meteorological and climatic conditions in the area(s) described in 1001.260(a)(1), including estimates of the frequency and severity of extreme meteorological events. §1001.260(a)(10) requires a description of the seismological conditions at the proposed site, including estimates of the frequency and severity of extreme seismological events.

Meteorological and climatic conditions will affect OTEC operations by posing direct wind forces and forces due to the build-up of waves and currents. Meteorological and climate conditions will also determine the trajectories of any air-borne contaminants that could potentially be released from an OTEC plant.

Seismological events could pose direct risks to an OTEC plant and indirect risk from the potential generation of tidal waves.

2.2.1.7 <u>§1001.260(a)(11)</u>. This section requires a description of physical oceanographic conditions in the areas(s) described under §1001.260(a)(1), including currents and tides. Information on advection and diffusion is discussed under §1001.260(a)(3) and should not be reproduced here. The vertical, spatial and temporal variations of seawater temperature, salinity and (thus) density are extremely important for determining and defining water mass types in the region; these parameters should thus be discussed under this section. Other physical oceanographic parameters of interest include waves and tides. References on these parameters are provided in Appendix B.

2.2.1.8 <u>§1001.260(a)(12)</u>. As discussed under Section 1.1.1 of this document, the OTEC Act requires each licensee to monitor the environmental effects, if any, of the operation their OTEC plant. Such monitoring is to be done in accord with requirements established by NOAA. In this regard, proposed regulations, §1001.260(a)(12), require an applicant to provide a description of a monitoring program to demonstrate compliance with applicable water quality standards, to provide for early detection of potential release of pollutants (as defined in §1001.40) from OTEC operations, and to monitor the effects of OTEC discharges on water, sediment, and biological quality. Although NOAA and the applicant may have to negotiate on the final monitoring plan, NOAA has intentionally put the burden of a monitoring plan on the applicant, believing the applicant will have the best information of hand to formulate a cost-effective, yet adequate monitoring program.

It is expected that the monitoring program will meet the requirements of the NPDES permit as well as address any other key issues identified in the environmental assessment. Furthermore, the monitoring program should reflect the applicant's understanding of the plant, the induced flow conditions, and the chemistry, geology, and biology of the area.

The monitoring program should be based on sound statistical principles, with sampling frequencies and locations selected so as to discern important changes with an acceptably low probability of either false negatives (deciding there is not a problem where, in fact, there is) or false positives (deciding there is a problem where, in fact, there is not). The probabilities of false positives and negatives that are factored into this analysis should reflect an understanding of the severity and costs of allowing such probabilities of error. Such considerations are discussed by Page (1978) and Raiffa (1970).

<u>2.2.1.9 §1001.260(b)</u>. This section addresses other factors and studies known to the applicant that may relate to the effects of an OTEC discharge. Applicants should consider both the quality and quantity of the discharge, and their variation over time, as well as the characteristics and sensitivity of the receiving waters in making this assessment.

2.2.2 Other Environmental Information

Environmental information requirements, in addition to §1001.260 are identified in the OTEC reegulations under §1001.210(b), §1001.210(g), and §1001.220(c).

2.2.2.1 §1001.210(b). This section requires compliance with applicable provisions of the Clean Water Act, including marine water quality criteria developed pursuant to Section 304(a)(1). These criteria are not rules and they have no regulatory impact. Rather, they present scientific data and guidance on the environmental effect of pollutants. The latest notice on the availability of water quality criteria documents (EPA, 1980) should be consulted for further details.

2.2.2.2 §1001.210(g). This section of the OTEC regulations will require an applicant to show compliance with State Coastal Zone Management plan that are either approved or being developed. Applicants in such states should review the NOAA Office of Coastal Zone Management Federal consistency regulations (43 FR 10517, March 13, 1978) for information on the proper form of certification and procedures for submission of the certification to the State or its designated coastal zone management agency.

2.2.2.3 §1001.220(c). This section calls for single-line drawings of the marine areas within five miles of the proposed site showing the nature and location of any cables, pipelines, offshore drilling or production platforms, aids to navigation, sewage outfalls, or other man-made structures and equipment. These drawings must also show the boundary lines and identification of each Outer Continental Shelf lease block, submarine transit lane, fishing ground, military use area, or other special area noted on navigation charts for the area covered by the drawing, or otherwise known to the applicant.

2.2.3 NEPA Requirements

In order to meet its responsibilities under NEPA, NOAA will depend upon the information discussed above under Environmental Information, plus the additional information discussed in Section 1.1.3, being integrated into a framwork that portrays the level of environmental risk. Although NOAA will write the EIS required under NEPA, it will be highly dependent upon the information provided by the applicant. Thus, the success of the EIS process and the timely processing of an application will depend upon the accuracy and sufficiency of the information provided by the applicant. NOAA requests that information include the following.

2.2.3.1 Alternatives Including the Proposed Action - The information provided under this heading will become the heart of the EIS that NOAA will prepare for each application. Based on the information provided under the Affected Environment (Section 2.2.2.2 below) and the Environmental Consequences (Section 2.2.2.3), this information should allow NOAA to make a comparison of the environmental effects (positive and negative), emphasizing the key issues, and to provide a clear basis for the choice of the preferable option. The NEPA requirements that NOAA will have to satisfy here are:

(a) Rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated.

(b) Devote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits.

(c) Include reasonable alternatives not within the jurisdiction of the lead agency.

(d) Include the alternative of no action.

(e) Identify the agency's preferred alternative or alternatives if one or more exists, in the draft statement and identify such alternative in the final statement unless another law prohibits the expression of such a preference.

(f) Include appropriate mitigation measures not already included in the proposed action or alternatives.

In order for NOAA to provide a high-quality EIS, it is recommended that applicants provide the best information that they can on these items. This should include a description of the national and regional needs for the subject OTEC development (§1001.180(e)(4), §1001.180(e)(6), §1001.180(e)(7)), a thorough description of the proposed project (§1001.190), and the estimated realm of influence (§1001.260(a)(1)).

Under the description of needs, the applicant might provide discussion of the regional energy demands, the modes and costs of meeting those demands presently and in the future, and the alternatives available, based on the information required by §1001.180(e)(6) of the regulations. Again, the information should be presented in such detail that the choices are relatively clear.

The description of the proposed project required by §1001.190 will be most useful if it provides a relatively non-technical description of the facilities including those aspects designed to reduce or mitigate environmental risk. A project timetable should also be provided (1001.190(b)) for the major phases of the project (siting, construction, operation, and possibly termination). Charts should also be provided, noting the locations of activities or resources within the potential area of influence (§1001.220(c)). Identification of the following types of activities or resources would be helpful when the applicant responds to these requirements of the regulations.

- ° All proposed construction (including surface and subsurface pipelines, power transmission lines, roads, bulk storage facilities, pumping stations, terminals, etc.)
- ° Political and geographic boundaries (state, county, and local)
- ° Major surface features (including elevations)
- ° Representative water depths
- ° Major population centers
- ° Ports
- ° Offshore exploration and exploitation activity
- ° Wildlife preserves, refuges, and management areas
- ° National, State, and local parks
- ° Major industrial areas
- ° Historic sites
- ° Major noise generators
- ° Specific sensitive receptors (such as hospitals and educational facilities)
- ° Commercial and recreational fishing areas
- ° Land use (e.g. residential, commercial, industrial, agricultural, etc.)
- ° Areas subject to flooding (both fresh and salt water)
- ° Requirements and proposed utilization for land, water surface, seabed, river, bottom, etc., quantified in acres
- ° Dredge spoil

- Wilderness areas
- Military/naval reservations
- Gunnery and torpedo ranges
- Restricted areas
- Submarine safety zones
- Ocean shipping transit lanes
- Anchorages
- Ocean dumping sites
- Submarine cables and pipelines
- Major transportation routes and corridors (railroad, highways, canals, etc.)

A discussion of the realm of influence should include a description of both atmospheric and marine flow in the vicinity of the site (§§1001.260(a)(9) and 1001.260(a)(11)), the implications (briefly) of these transport patterns on activities and other resources (§§1001.220(c), and 1001.260(a)(7) and (a)(8)), and the extent of primary and secondary land-side effects (§§1001.190(b) and 1001.220(b)). The latter should further include consideration of terrestrial and socio-economic effects (§1001.180(e)(4) and (e)(6)).

2.2.3.2 Affected Environment - The EIS that NOAA is to prepare must also describe the environment of the area(s) to be affected by the alternatives under the consideration. Accordingly, NOAA requests that the applicant provide such information, commensurate with the importance of the impact (§1001.260).

The descriptions of the atmospheric environment may include air circulation patterns, meteorology and climatology, and air quality (§1001.260(a)(9)). Particular attention should be given to extreme events such as hurricanes.

Such extreme events may also cause extreme events for other parameters, as in the case of extreme winds leading to the occurrence of say, for instance, the 100-year wave. Such consideration should provide insights into the implications for impacts due to OTEC plants.

Descriptions of the marine environment will, perhaps, be the most complex. In general, an applicant should provide information of the physical, geological, chemical and biological oceanography of the proposed OTEC site and for nearby waters that either may be influenced by, or would influence the intake and discharge of waters by the plant.

The physical oceanographic assessment should give particular attention to tides, currents, circulation and waves; vertical density structure; and horizontal and vertical disperson coefficients (§1001.260(a)(11)). These parameters will influence both the plant (drag and impact forces due to currents and waves) and the intake and discharge flow fields.

Geological considerations should include underwater bathymetry/ topography, substrate type and stability, seismic activity, sedimentation patterns, and other parameters that may be of pertinence, (§1001.260(a)(10)).

Chemical oceanographic characterizations should provide information on light transmission, nutrients, alkalinity, pH, dissolved oxygen, temperature and salinity, total and particulate organic carbon, trace metals (dissolved and particulate), and oil and grease (§1001.260(a)(3)). These parameters will be useful for assessing the degree and effects of water mass redistributions caused by the operational phase of OTEC plants.

Biological descriptions should include those parameters that influence the environmental concerns discussed earlier under Section 2.2.1. This discussion should also include any other information that is judged by the applicant to be pertinent to the case or to the NEPA requirements (§1001.260(b)). Literature reviews and field sampling will probably be necessary to characterize the biological resources of the area. These efforts should address phytoplankton, zooplankton, bethos, finfish, shellfish, mammals, sea and shore birds, aquatic vegetation, productivity, food chains, communities, and life cycles of important species. If possible, indicator species or physiological characteristics that may reflect the levels of certain types of stress should be identified. Particular attention should be given to species that spawn and nurse in the area, that use the area for passage during migration, and that are on the endangered or threatened species list. Some of the species under the latter category are indicated in Tables 2 and 3.

2.2.3.3 Environmental Consequences - Information on environmental consequences will form the basis for much of the discussion under "Alternatives Including the Proposed Action" (Section 2.2.2.1, above); Consequently, NOAA's discussion here will include the environmental impacts of the alternatives including the proposed action, any adverse effects which cannot be avoided should the proposal be implemented, the relationship between short-term uses of the environment and the maintenance and enhancement of long term productivity, and any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented.

Since potential environmental effects due to OTEC construction and operation may impact the terrestrial, atmospheric, and marine environments, all such significant possibilities will have to be addressed. It is expected that the majority of potentially negative environmental effects will be associated with the marine environment. These effects and the associated

TABLE 2 THREATENED AND ENDANGERED SPECIES OF THE OTEC RESOURCE AREA (TERRESTRIAL)
Source: Sands, 1980.

Scientific Name	Common Name	Status	Distribution
	Crocodiles and Alligators		
Crocodylus acutus	American crocodile	E*	South Florida
Crocodylus novaesquineas mindorensis	Philippine crocodile	E	Philippines (and Palau, TTPI**?)
Crocodylus rhombifer	Cuban crocodile	E	Cuba (Caribbean?)
Alligator mississ-ippiensis	American alligator	T	Southeastern United States
	Other Reptiles		
Cyclura pinquis	Anegada Island ground iguana	E	Virgin Islands
Cyclura stejnegeri	Mona Island ground iguana	T***	Puerto Rico
Epicrates inornatus	Puerto Rican boa	E	Puerto Rico
Ameiva polops	St. Croix ground lizard	E	St. Croix, Virgin Islands
	Amphibians		
Eleutherodactylus jasperi	Goldon coqui	T	Puerto Rico
	Birds		
Acrocephalus familiaris kingi	Nihoa miller-bird	E	Nihoa, Hawaiian Islands
Psittirostra cantans cantans	Laysan finch	E	Laysan, Hawaiian Islands
Anas laysannensis	Laysan duck	E	Laysan, Hawaiian Islands
Anas wyvilliana	Hawaiian duck	E	Hawaiian Islands
Anas oustaleti	Marianas mallard	E	TTPI, Micronesia
Fulica americana alai	Hawaiian coot	E	Hawaiian Islands
Caprimulgus noctitherus	Puerto Rican whip-poor-will	E	Puerto Rico
Amazona vittata	Puerto Rican parrot	E	Puerto Rico
Columbia inornata wetmorei	Plain pigeon	E	Puerto Rico
Agelaius xanthomus	Yellow-shouldered blackbird	E	Puerto Rico
Falcon peregrinus anatum	American peregrine falcon	E	North American, Carribean
Himantopus himantopus knudseni	Hawaiian stilt	E	Hawaiian Islands
Gallinula chloropus sandvicensis	Hawaiian gallinule	E	Hawaiian Islands
Branta sandvicensis	Hawaiian goose	E	Hawaiian Islands

*Endangered
**Trust Territories of the Pacific Islands
***Threatened

TABLE 3

THREATENED AND ENDANGERED SPECIES OF THE OTEC RESOURCE AREA (MARINE)

Source: Sands, 1980.

Scientific Name	Common Name	Status	Distribution
		Marine Mammals	
Balaenoptera musculus	Blue whale	E*	Oceanic, Pacific, Atlantic
Balaenoptera borealis	Sei whale	E	Oceanic, Pacific, Atlantic
Balaenoptera physalus	Finback whale	E	Oceanic, Southern Hemisphere
Eschrichtius gibbosus	Grey whale	E	Oceanic, off western North America
Eubalaena glacialis	Right whale	E	Oceanic, Pacific, Atlantic
Megaptera novaeangliae	Humpback whale	E	Oceanic, Caribbean, North Pacific, Atlantic
Physeter catodon	Sperm whale	E	Oceanic, Caribbean, Pacific, Atlantic
Dugong dugong	Dugong	E	Micronesia, Western Carolines, TTPI**
Trichechus manatus	Caribbean manatee	E	Off Florida, Caribbean
Monachus schauinslandi	Hawaiian monk seal	E	Northwest Hawaiian Islands
Monachus tropicalis	Caribbean monk seal	E	Caribbean (extinct?)
		Sea Turtles	
Chelonia mydas	Green sea turtle	T*** E	Hawaii Florida, Pacific coast of Mexico
Eretmochelys imbricata	Hawksbill	E	Micronesia, TTPI, Gulf of Mexico
Dermochelys coriacea	Leatherback	E	Micronesia, TTPI, Caribbean, Gulf of Mexico
Lepidochelys kempii	Kemp's ridley	E	Caribbean, Gulf of Mexico
Lepidochelys olivacea	Olive ridley	T E	Tropical circumglobal, Pacific coast of Mexico
Caretta caretta	Loggerhead	T	Tropical circumglobal
		Birds	
Pelecanus occidentalis	Brown pelican	E	Caribbean, U.S. west coast, Gulf coasts
Puffinus puffinus newelli	Newel's Manx shearwater	T	Hawaiian Islands
Pterodroma phaeopygia sandwichensis	Hawaiian dark-rumped petrel	E	Hawaiian Islands

*Endangered
**Trust Territories of the Pacific Islands
***Threatened

activities are listed in Table 4, along with an indication of probable severity (NOAA, 1981a). Further details of the potentially major impacts and possible mitigating strategies are presented in Table 5. This discussion will also address effects on human activities, as well as other indirect effects. Such a discussion will include potential impacts on:

- o Commercial and recreational fishing
- o Shipping and transportation
- o Naval operations
- o Scientific research
- o Recreation
- o Aesthetics
- o Socio-economics

Some of the information needs for developing the environmental consequences section are required under §1001.190 (General information on the OTEC facility or plantship), §1001.210 (compliance with other Federal laws and regulations, §1001.220 (OTEC site information), and §1001.260 (Environmental information). Although NOAA bears the burden burden of developing the discussion on these matters under NEPA, any pertinent insights and information that an applicant may have will be most appreciated.

2.2.4 Additional Guidance to Applicants

The Department of Energy (1980) published data requirements related to the environmental design and operational criteria for DOE supported OTEC pilot plants. This information is reproduced in Appendix B because of its potential value to an applicant. It should not be construed as representing requirements for an application for a commercial license. It is intended to be informative only, providing an indication of the

TABLE 4

<u>Major Effects:</u>

• Platform presence	- Organism attraction or avoidance
• Withdrawal of surface and deep-ocean waters	- Organism entrainment and impingement
• Biocide release	- Organism toxic response
• Discharge of waters	- Nutrient redistribution, resulting in increased productivity

<u>Minor Effects:</u>

• Protective hull-coating release	- Toxic effects and bioaccumulation of trace metals
• Power cycle component erosion and corrosion	- Toxic effects and bioaccumulation of trace constituents
• Implantation of cold-water pipe and transmission cable	- Short-term habitat destruction and turbidity during implantation
• Low-frequency noise	- Interference with organism behavior and communication
• Discharge of surfactants	- Toxic effects to resident organisms
• Open-cycle plant operation	- Alteration of oxygen and salt concentration of downstream waters

<u>Potential Effects from Accidents:</u>

• Potential working fluid release from spills and leaks	- Organism toxic response
• Potential oil releases	- Organism toxic response

TABLE 5 POTENTIALLY ADVERSE ENVIRONMENTAL IMPACTS AND MITIGATING MEASURES

Issue	Community Affected					Mitigating Measures (Ranked by Effectiveness)	Research Needs
	Plankton	Nekton	Benthos	Threatened and Endangered Species	Man's Activities		
Biota Attraction and Avoidance	Increased number of organisms due to attraction to lights.	Increased number organisms due to attraction to structure and lights.	Colonization of exposed structures.	Possible avoidance of area due to human presence and noise.	-Increased fishing. -Loss of desired faunal diversity.	-Site away from breeding and nursery grounds. -Reduce lights and noise to minimum needed for safe operation. -Reduce attraction surfaces.	-Site evaluation studies to determine ecological sensitivity of areas. -Determine biota attraction and avoidance to different platform configurations and lighting systems.
Organism Entrainment	Reduction in population size.	-Reduction in population size due to mortality of eggs and larvae. -Potential reduction in food resources.	Reduction in population size due to mortality of planktonic larval stages.	Possible reduction in food resources.	Potential decrease in fishery resources.	-Site intakes away from ecologically-sensitive areas. -Site intakes at depths that will entrain the least number of organisms. -Reduction in through-plant shear forces.	-Site evaluation studies to determine ecological sensitivity of area. -Determine vertical distribution of local populations. -Entrainment mortality studies that determine plant induced mortality.
Organism Impingement	None.	Reduction in population size due to mortality of juveniles and adults.	None.	None.	Potential reduction in fishery resources.	-Use velocity caps to achieve horizontal flow fields. -Use fish return system. -Site intakes at depths that will impinge the least number of organisms. -Reduce intake velocities.	-Site evaluation studies to determine ecological sensitivity of area, and size, structure, and vertical distribution of fish populations. -Impingement mortality prevention studies.

Table 5 Potentially Adverse Environmental Impacts and Mitigating Measures (Continued)

Issue	Community Affected					Mitigating Measures (Ranked by Effectiveness)	Research Needs
	Plankton	Nekton	Benthos	Threatened and Endangered Species	Man's Activities		
Biocide Release	Reduction in population size.	-Decreased metabolic activity and plume avoidance by adults. -Reduction in population size due to mortality of eggs and larvae.	-Reduction in population size due to mortality of planktonic larval stages. -Chronic or acute effects on adults.	-Possible avoidance of plume. -Possible reduction of food resource.	-Potential reduction of fishery resources. -Decreased aesthetics.	-Discharge below photic zone. -Use alternate methods for biofouling control. -Rapid dilution through use of diffusers. -Site specific biocide release schedule and concentration. -Site discharges away from ecologically-sensitive areas.	-Site evaluation studies to determine ecological sensitivity of area. -Acute and chronic toxicity and bioassay studies on representative organisms.
Nutrient Redistribution	Increased productivity. Changes in species composition.	Potentially increased food resource. Potentially decreased food resources.	Potentially increased food resource. Potentially decreased food resources.	Potentially increased food resource. Potentially decreased food resources	-Potential increase in fishery resource. -Potentially decreased aesthetics.	Discharge into photic zone. Discharge below photic zone.	Determine discharge plume stabilization depth and downstream mixing rate so that physical models can be calibrated.
Sea-Surface Temperature Alterations	None.	None.	None.	None.	Potential climatic alterations.	Discharge below the thermocline.	Monitor temperature-density profiles from OTEC discharges to calibrate predictions.

types of parameters (and references) the applicant might consider for its data base, and an idea of possible frequencies for sampling. The applicant can refer to this in judging the needs for their individual environmental assessments and proposed monitoring programs.

The frequency and time-span of data presented in the application, and proposed for the monitoring program, should reflect the applicant's understanding of both NOAA's (and other Federal agencies') needs and the site-specific considerations of the local environment. Natural variabilities and long-term trends will be of extreme interest; thus, generally, information indicating annual cycles (minimum of one year) should be presented. However, the needed amount and accuracy of information will be dependent upon the potential seriousness or risk of resulting problems. Such information may be from the literature, historical data bases, or from new field efforts.

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Appendix A

EPA List of Pesticides and Toxic Pollutants

from EPA, 1979

Table

Pesticides:
- Mirex
- Guthion
- Methoxychlor
- Parathion
- Demeton
- Malathion

Toxic Pollutants
- Acenaphthene
- Acrolein
- Acrylonitrile
- Aldrin/Dieldrin
- Antimony and compounds
- Arsenic and compounds
- Asbestos
- Benzidine
- Beryllium and compounds
- Cadmium and compounds
- Carbon tetrachloride
- Chlordane (technical mixture and metabolites)
- Chlorinated benezenes (other than dichlorobenzenes)
- Chlorinated ethanes (including 1, 2-dichloroethane, 1.1.1-trichlorethane, and hexachloroethane)
- Chloroalkyl ethers (chloromethyl, chloroethyl, and mixed ethers)
- Chlorinated naphthalene
- Chlorinated phenols (other than those listed elsewhere; includes trichlorophenols and chlorinated cresols
- Chloroform
- 2-chlorophenol
- Chromium and compounds
- Copper and compounds
- Cyanides
- DDT and metabolites
- Dichlorobenzeness (1,2,-1.3-and 1.4-dichlorobenzeness
- Dichlorobenzidine
- Dichloroethylenes (1.1- and 1,2-dichlorethylene
- 2,4-dichlorophenol
- Dichloroprane and dichloropopene
- 2,4-dimethyphenol
- Dinitrotoluene
- Diphenylhdrazine
- Endosulfan and metabolites
- Endrin and metabolites
- Ethylbenzene
- Fluoranthene
- Haloethers (other than those listed elsewhere; includes chlorophenylphenyl ethers, bromophenylphenyl ether, bis-(chlorethoxy) methane and polychlorinated diphenyl ethers)
- Halomethanes (other than those listed elsewhere; includes methlene chloride, methychloride, methylbromide, bromoform, dichlorobromomethane, trichlorofluoromethane, dichlorodifluoromethane)
- Heptachlor and metabolites
- Hexachlorobutadiene
- Hexachlorocyclopentadiene
- Isophorone
- Lead and compounds
- Mercury and compounds
- Napthalene
- Nickel and counds
- Nitrobenzene
- Nitrophenols (including 2,4,-dinitrophenol)
- Nitrosamines
- Pentachlorophenol
- Phenol
- Phthalate esters
- Polychlorinated biphyenyls(PCBs)
- Polynuclear aromatic hydrocarbons including benzanthracenes, benzopyrenes, benzofluoranthene, chrysenes, dibenzanthracenes, and idenopyrenes)
- Selenium and compounds

Silver and compounds
2,3,7,8-Tetrachlorodibenzo-p-dioxin
(TCDD)
Tetrachloroethylene
Thallium and compounds
Toluene
Toxaphene
Trichloroethylene
Vinyl chloride
Zinc and compounds

APPENDIX B
(from DOE, 1980)

This material is directly excerpted from DOE's requirements for environmental data associated with the development of pilot plants under DOE support. It is for reference only in this Technical Support Document; it does not imply any requirements related to an application for commercial OTEC development.

I. SITING CRITERIA-ENVIRONMENTAL DESIGN AND OPERATIONAL CRITERIA

Data requirements in this section are primarily directed toward the establishment of the OTEC plant design and operational criteria at the OTEC pilot plant site, the shore-based construction and deployment site (if applicable), and the associated cable route. The results are to be used by the design engineer/naval architect in the development of all related OTEC ocean systems such as the mooring and transmission systems, the cold water pipe, the helicopter and supply boat operations, etc. The numbers refer to previous studies (see references for this appendix) where these data have been reported, analyzed and/or used on OTEC studies.

Data Requirements	References
A. Meteorological Data	
1. General description of the major climatic systems and of the local climatic conditions	2,3,5,8
2. Normal climatology and variability (by months)	
a. barometric pressure	71
b. wind velocity (frequency and persistence)	10,14,71
c. cloud coverage and visibility	71
d. solar radiation (nearest land and site)	5
e. air temperature	71
f. relative humidity	71
3. Extreme meteorological events	
a. major storms (classes and dates of occurrence)	67,72
b. frequency and intensity of storms	9,67,72
i. barometric pressure distribution	9,67,71
ii. speed and direction of storm movement	9,67,72
c. extreme wind velocity	
i. boundary layer wind profile	67
ii. wind speed duration (sustained versus gust)	9,67
iii. wind speed distributions (recurrence intervals)	9,14,67
d. long-term variability of storms, hurricanes	None

Data Requirements	References
B. Oceanographic Data	
1. General description of the major oceanographic systems and of the regional oceanographic features in terms of ocean currents and water masses........	2,3-5,21,25,29
2. Normal marine climatology and variability (by months)	
a. Wave parameters	
i. height (frequency and persistence)........................	10,14,71
ii. period (with heights)..............	10,14,71
iii. direction (with heights)...........	10,14,71
iv. directional wave energy spectra (mean and variability)............	10
b. current velocity parameters	
i. tidal current roses (spring, mean, and neap)....................	10
ii. local geostropic currents (seasonal variability)............	5,10,14,25
iii. normal wind currents..............	8,21
iv. composite of i,ii, and iii into frequency and persistence distribution......................	20,71
v. normal current velocity profiles and variability...................	9,20
vi. internal wave heights, currents and frequencies..................	None
vii. large scale circulation at critical depths.............................	8,29-34
c. sea water elevations (for shelf/shore installations)	
i. tidal height ranges (mean to spring tides)......................	None
ii. annual sea level variations (river and wind)...................	None
iii. dynamic height topography...........	29,34,35
iv. barometric pressure fluctuations...	None

Data Requirements	References
d. physical water properties	
i. sea water temperature profile (by month)	14
ii. salinity and density profiles (by month)	14
iii. transparency	None
3. Extreme oceanographic events	
a. wave parameters (for selected recurrence intervals)	
i. maximum & significant wave height	9,14
ii. maximum & significant wave period	9,14
iii. primary wave direction	9,14
iv. directional wave energy spectrum	9,14
b. current velocity	
i. extreme currents due to wind, tide and geostrophic components	9,14
ii. the component of (i) in the direction of and at the time of maximum wave heights	9,14
iii. extreme currents due to non-storm conditions	14,25,26
c. sea water elevations (for shelf/shore installations)	
i. composite storm water elevations	None
ii. maximum storm water elevation at time of maximum wave height	None
d. extremes of other physical water properties	
e. long term variability of extreme oceanographic parameters	22,23
f. statistical extrapolation to design recurrence intervals	9,14
g. joint probability distribution of the independent storm classes	14
C. <u>Other Design Data</u>	
1. Earthquake and tsunami frequency and intensity	10

Data Requirements	References
2. Geological conditions	
a. bathymetry..................................	5,16,61,97
b. properties and thicknesses of subsurface sediments for mooring	16,61
c. stability of sea floor sediments and other soil mechanics properties (i.e., for anchor holding properties).........................	None
3. General oceanographic conditions enroute from the deployment site to the cable shore end	
a. bathymetry along the cable route..........	16
b. type and depth of subsurface sediments for cable support/trenching....................	16
c. stability of sea floor sediments along cable route (include scour, slumping, sandwaves, etc.).....................................	None
d. bottom temperatures and current velocity enroute....................................	None
e. identify all pipelines, submarine cables, military or fishery exclusion zones, archeological sites, live coral reefs, marine sanctuaries and other exclusion zones.....................................	59,60

D. Shorebased Facility

Comparable design/operational criteria must also be developed for coastal installations and construction areas. Considerable information developed for the OTEC site may be applicable to the coastal locations or can be modified for the new depths, etc.

II. THERMAL RESOURCE-EVALUATION AND VARIABILITY

The thermal resource is the single most important aspect of the environmental data requirements. Although the temperature profile is easily measured at a site, it varies because the water masses are continuously moving, as well as being altered by other physical processes, i.e., both local and advective changes are occurring, especially in the upper layers. Since an annual cycle exists, this represents a minimum period of data measurement. Because the environmental conditions of the site can vary significantly year to year, several years of measured data are necessary. Longer variations (over several decades) should be estimated from shipboard observations of the sea surface temperatures. In some regions more frequent variations occur in response to cold fronts, tropical storms and meandering eddies. Hence, these processes must be understood and quantified with a more frequent measurement program such as with satellite surface temperature maps and in situ confirmation.

OTEC plants will also induce both small scale (near field) and large scale (far field) changes in the seawater temperatures depending on their size, number and operating duration. The potential problems range from local recirculation of the effluent to major erosion of the thermal resource in semi-enclosed waters. Other problems develop from the transport of nutrient enriched and possibly chlorinated effluents. Whereas measurements cannot predict these events, they do provide input data to both physical and mathematical models which can be used for predictions. It should be noted that DOE has or is presently developing several numerical and physical models which will become available for use with the data (Section VI-G). These on-going studies represent DOE's approach to the problems involving the thermal resource and its variability and alteration by OTEC plants and does not preclude the offeror from proposing other comparable techniques, models, etc.

The required data and studies are outlined as follows:

Data Requirements	References
A. General Area Resource Description (Preliminary results from historical data - Phase I)	
1. Mean distribution and monthly variability	
a. temperature profile and thermal difference	20,29-34,37-45, 65,70,81-82
b. mixed layer depth	7,20-21,29-34, 37-45,65,70,80
c. thermocline depth	20-21,29-34,37-45, 65
d. seawater density profile	20-21,29-34,65
e. horizontal distribution of sea surface temperature	20,29-30,37-43

Data Requirements	References
2. Mean ocean current distribution and variability	
a. vertical distribution of horizontal currents..........................	20,25,29-34
b. near field circulation.............	29-34,65
c. large scale circulation............	8,20,25,60
B. Site Specific Thermal Resource Description (Measured field data at the site - Phase II)	
1. Mean distribution and monthly variability of the resource. (Repeat of A-1 using measured field data with technical requirements in Table 1 enclosed)	20,28,31-34, 65,68
2. Mean ocean current distribution and variability (Repeat of A-2 using measured field data with technical requirements in Table 2 enclosed).........	20,28,31-34, 65,68
C. Natural Variability of the Thermal Resource. Researchers have shown that significant long and short term temperature variations occur resulting from major long period atmospheric and oceanic conditions and from short period storms, eddies, etc., which will influence OTEC operations and siting criteria.	
These must be evaluated.........................	22,23,29,74-75
1. Long-term sea surface temperature changes	
a. annual sea surface temperature distributions.........................	23,24
b. estimated minimum thermal difference versus recurrence intervals..................	None
2. Short-term sea surface temperature changes such as cold fronts, hurricanes, eddies, upwelling, etc.............................	None
D. OTEC Induced Variability of Thermal Resource and Related Plume Dispersion	

The OTEC pilot plant will alter and redistribute the ambient warm and cold seawater causing two effects: (1) recirculation of the effluent within the plant and (2) redistribution of nutrient enriched and possibly chlorinated seawater. The first effect primarily impacts on engineering design features and plant spacing whereas the second is a bio-ecological consideration. Both are by-products of the resource utilization. The offeror(s) must address both effects. DOE studies now in progress should be consulted for application to the OTEC pilot plant, although other methods may also be acceptable. Site and regional measurements of the current velocity and the water masses (T and S o/oo) are required for input data. These areas of interest must be evaluated for the following:

	Data Requirements	References
1.	Near and intermediate fields..............	1,48–49,50, 63–64
	a. potential for recirculation (short-term).....................................	None
	b. plume dynamics.........................	48–49,56
	c. chlorination levels...................	None
2.	Far Field	
	a. potential for recirculation............	26
	b. degradation of thermal resource by other OTEC plants...........................	None
3.	Field measurements (see Tables 1 and 2)	
	a. near field - vertical current velocity above thermocline, seawater density profile and, after OTEC installation, plume measurements (at the site)........	20,56–57
	b. far field - horizontal currents over large area (i.e., the regional circulation) and seawater density profiles................................	26,57,66

4. Site specific measurements

   a. Site specific measurements are presently being conducted at several potential OTEC sites. The most recent installation at a site of interest reflects baseline current measurement concepts. Exhibit A of this PON (Section VI) outlines the measurement program and includes the sample rate, frequency, numbers of meters, etc., which can be used as guide for future planning. Other sites may have different requirements than this site depending on available historical data and the complexity of the parameters being measured.

III. Bio-Ecological/Chemical Requirements

A bio-ecological/chemical program must be initiated to take background data before placement of an operating OTEC pilot plant at the proposed site. This is required to insure that baseline information is available to evaluate the effects of OTEC on the ambient environment, to provide environmental data useful in the design of the operating system and to comply with NEPA/NPDES. To characterize each site, a reconnaissance benchmark is located. A benchmark is defined as a specific location, typical of a subregion, where serial data are taken and to which historical data may be referred.

Because of the lack of serial, long-term records of any kind in the proposed OTEC regions, the benchmark approach is more valuable in the long-term than initiating broad regional surveys where variations in measurements may be attributed to site as well as time variability. If substantial subregional variability is found, the benchmarks can be used as starting points for potential regional surveys. The intent of taking measurements at benchmarks is to provide data, at a specific location, which will form the basis, in conjunction with previously obtained data from the area, for defining longer term and more comprehensive environmental surveys required for the siting and permitting of OTEC plants in the designated thermal regions. The baseline data will form a significant part of the EIS (if required) prior to any construction or operations.

As the OTEC pilot plant is placed in operation, the baseline survey is replaced by an environmental monitoring study. Environment monitoring checks are required to maintain the NPDES permit, as well as to determine how the bio-ecology and seawater chemistry are affecting the OTEC pilot plant operation in terms of biofouling, biostimulation, corrosion, etc.

After completion of OTEC pilot plant Phase VI (operation) a post-operation baseline survey will be required to determine the long-term effects of the OTEC operation. These general requirements are contained in the NEPA; and will be specified in the EA/EIS and/or NPDES.

A. Program Purpose

The general purpose of the bio-ecological/chemical studies program is to determine how OTEC operations will alter site-specific marine environments, and conversely, how the local character of the marine ecosystem affects OTEC operations. This program will include the following tasks:

1. A survey and summary of all available historical information.

2. The implementation of field programs designed to collect the necessary information not available from previous work.

3. The implementation of on-going laboratory studies to assess the toxicological effects of OTEC operations on marine organisms.

4. The presentation of data in an accessible form for use in EA/EIS documents (see subsection IV of this appendix).

5. The recommendations of mitigating strategies concerned with bio-ecological/chemical effects.

B. General Area Bio-Ecological and Chemical Requirements.

The following list of bio-ecological and chemical information must be developed for the OTEC site. As in previous data requirements sections, the initial approach will be to collate and summarize existing data. This shall be followed by a field measurement program which will provide site specific data if incomplete data records exist.

	Data Requirements	References
1.	Temperature and salinity...........	13,20-21,50,52-55
2.	Dissolved oxygen....................	13,20-21,50,52-55
3.	Nutrients (nitrate plus nitrite, orthophosphate, total phosphate, nitrite, ammonia, silicate)........	12,13,50-55
4.	Light transmittance................	None
5.	Chlorophyll $\bar{a}$......................	20,50,52-55
6.	Phaeophytins.......................	None

Data Requirements	References
7. Adenosine triphosphate (ATP)	18,50,52-55
8. Organisms (phytoplankton & zooplankton)	8,11,17,76
9. Alkalinity...........................	None
10. Total and particulate organic carbon..............................	None
11. Primary productivity and biostimulation..............................	50,52-55
12. Trace metals (copper, manganese, iron, aluminum, titanium, cadmium, chromium, cobalt and nickel)	20,50,52-55
13. Oil and grease......................	None
14. Miscellaneous (nekton, mammals and birds)	20,46-47

C. Site Specific Bio-Ecological and Chemical Requirements

Site specific data must be gathered at the proposed OTEC site if insufficient data exists to perform the required analysis for engineering, environmental and regulatory needs. In addition, the field measurement program will allow the contractor to acquire and analyze the field data using techniques which have approval of DOE and EPA. At this time and stage of OTEC development, there is no specific document which outlines a measurement program, such as the US Nuclear Regulatory Commission regulatory guide for nuclear power plants. Consequently, acceptable environmental studies and data measurement programs are in a state of evolution which reflect a composite thinking of classical oceanographic studies coupled with modern ocean engineering/environmental requirements tailored to a new oceanic system which has not been placed in the field. The result is a continuing reassessment and development of theoretical, laboratory and field measurement programs, instrumentation and analytical techniques and even priorities and relevance of specific programs. Consequently, the requirements are continually being reevaluated and open to new ideas. Conversely, many programs initiated in the early phases of OTEC research are obtaining approval by EPA.

Table 3 lists the bio-ecological/chemical parameters requirements and the recommended station and sample frequencies for these measurements. Table 4 lists the precision of the chemical analysis. These requirements will vary with stages of development of the OTEC pilot plant, more complete data requirements as the program becomes defined and the final sites selected.

Exhibit B (Section VI) is a brief summary of the latest OTEC specification for biological measurement at a potential OTEC site. These analytical methods have DOE-approval and have been generally accepted by EPA.

D. Special Studies

These studies incorporate both site measurements and numerical/analytical/laboratory models which are being developed under contracts to DOE and which will be made available as the research is completed. The net benefits are mostly to provide data; (1) for engineering design studies, or (2) for EA/EIS requirements for final system design. The offeror(s) will become knowledgeable of the ongoing special studies now in progress at DOE or their designated contractors. Offeror(s) will then apply the measured data (item 1. below) to the particular special study (items 2-6) using these models or techniques and the engineering properties of the OTEC pilot plant. Other comparable models/techniques may be used provided their applicability/accuracy can be justified to DOE.

1. Biological and ecological data base

2. Toxicity and impingement-entrainment impact studies

3. Quantification of temporal distribution of aquatic populations at OTEC sites

4. Assessment of fisheries impact

5. Primary productivity (biostimulation) from nutrient enrichment

6. Ecological/effluent mixing models in conjunction with plume dynamics

E. Environmental Monitoring Program

An environmental monitoring program will be required once the OTEC pilot plant has been placed into operation. This program will require measurements to monitor changes to the seawater's bio-ecology and chemistry as treated cold and warm water effluents are discharged and a new bio-ecological equilibrium condition is reached. Measurements will also be necessary to evaluate bio-engineering problems related to the OTEC operation. The actual monitoring program will be more specifically defined as results from OTEC-1 are made available and changes are incorporated. For present planning purposes, the OTEC-1 monitoring proposal has been briefly summarized as Exhibit C (Section VI) as a guide to future program development.

Also as a part of the maintenance of the NPDES permit, all discharges from the OTEC pilot plant must be monitored periodically. These discharges include OTEC evaporator and condenser water, bilge water, engine cooling water, sea water from fire pumps, boiler blowdown, distilling plant brine, refrigeration cooling water, etc. Samples of the temperature, residual chlorine, suspended solids, ammonia, titanium, iron, aluminum, nitrates, phosphates, silicates, etc. must be monitored. EPA (local regional or state office as appropriate) will specify limits and/or monitoring requirements (see, for example the OTEC-1, Draft NPDES Permit No. HI 0110272 reference 83 of this appendix).

Table 1. Properties of the temperature field, their effect on design, and required accuracy and spatial and temporal resolution of an observation program.

	Property	Design Requirement	Accuracy	Spatial Resolution	Temporal Resolution	Remarks
1)	Temperature distribution a) 0-100 m b) 900 m - 1100 m	Thermal resource Length of cold pipe Size of heat exchanger	$\pm .1^{o}C$	a) 0-100 m 10 m's b) 900 m - 1100 m 50 m's	daily	Resource determined by a layer of finite thickness; therefore data required over larger interval than merely sea-surface or 1000 m.
2)	Mixed layer depth	Depth of intake and discharge Recirculation studies	$\pm$ 10 m		daily	
3)	Thermocline depth	Depth of intake and discharge Type of discharge Recirculation studies	$\pm$ 10 m		daily	Seasonal thermocline can cause significant temperature gradients near sea-surface
4)	Density distribution	Pumping requirements Effect of discharge on environment	$\pm .002\ gm/cm^3$	Continuous to 1000 m	seasonal	Salinity observations required to determine density
5)	Horizontal distribution of temperature	Thermal resource Effect of discharge on plant	$\pm .1^{o}C$	a) Moored OTEC 25 km around site b) Grazing OTEC entire site	bi-monthly	The existence of temperature fronts and their spatial and temporal evolution is required
6)	Extreme events (hurriances, cold fronts)	Thermal resource	$\pm .5^{o}C$	Event spatial scale	Event time scale	Duration of recovery period to pre-event conditions must be determined

Table 2. Properties of ocean current distribution, their effect on design, and required accuracy and spatial and temporal resolution of an observational program.

Property	Design Requirement	Accuracy	Spatial Resolution	Temporal Resolution	Remarks
1) Vertical distribution of horizontal currents	Mooring Cold water pipe Loading Fatigue Propulsion	$\pm 10^{o}$ ± 5 cm/sec	Minimum -5 depths, 50, 100,150, 200 m, 1000 m	hourly	Time series required to compute statistics to flow variability. Meter depths can vary depending on local conditions.
	Same as above	$\pm 10^{o}$ ± 10 cm/sec	Continuous in vertical	seasonal	Necessary to insure proper placement of current meters.
2) Near-field circulation	Recirculation Environmental impact	$\pm 10^{o}$ ± 5 cm/sec	5 km-25 km	hourly	Requires placement of several current meter moorings at site.
3) Large-scale circulation	Environmental impact	$\pm 20^{o}$ ± 20 cm/sec	50 km-100 km	seasonal	Circulation patterns can be inferred from geostrophic calculations, drift bottle studies, water mass distributions, etc. important to define vertical as well as horizontal motions.
4) Extreme events (hurricanes, cold fronts)	Plant survival	$\pm 20^{o}$ ± 20 cm/sec	Event spatial scale	Event time scale	Duration of recovery period to pre-event conditions must be determined.

TABLE 3

BIO-ECOLOGICAL/CHEMICAL REQUIREMENTS**

PARAMETER	OPERATION	FREQUENCY	FREQUENCY
Temperature	hydrocast	bi-monthly	all hydrocasts
Temperature	STD, XBT	bi-monthly	4STD, 12XBT
Salinity	hydrocast	bi-monthly	all hydrocasts
Salinity	STD	bi-monthly	4STD
Water currents	current meters	continuous	1 per 15 min., typically
	profiler	bi-monthly	4 casts
Dissolved Oxygen	hydrocast	bi-monthly	2 casts
Orthophosphates	hydrocast	bi-monthly	2 casts
Total Phosphate	hydrocast	bi-monthly	2 casts
Silicate	hydrocast	bi-monthly	2 casts
Nitrate plus nitrite	hydrocast	bi-monthly	2 casts
Nitrite	hydrocast	bi-monthly	2 casts
Ammonia	hydrocast	bi-monthly	2 casts
Chlorophyll $\bar{a}$ Phaeophytin	hydrocast	bi-monthly	2 shallow casts
Phytoplankton	hydrocast	bi-monthly	2 shallow casts
Zooplankton	net tow	bi-monthly	2 tows
Trace Metals*	hydrocast	every 4 months	1 cast
Alkalinity	hydrocast	every 4 months	2 casts
C^{14} uptake	hydrocast	every 4 months	1 cast

PARAMETER	OPERATION	FREQUENCY	FREQUENCY
ATP (adenosine triphosphate)	hydrocast	every 4 months	2 shallow casts
Dissolved Organic Carbon	hydrocast	every 4 months	1 cast
Particulate Organic Carbon	hydrocast	every 4 months	1 cast
Oil and grease	hydrocast	every 4 months	1 shallow cast
Nekton, mammals, birds	visual	bi-monthly	as sighted

*Copper, manganese, iron, aluminum, titanium, cadmium, chromium, cobalt, nickel, zinc and tin.

**Assumes no previous data are available. See Exhibit C (Section VI) for typical specifications at potential OTEC site for more detail.

TABLE 4

CHEMICAL DATA

Precision

	$\pm$	
Dissolved Oxygen	0.01 ml/l	@ ml/l
pH	0.01 pH units	
Nitrate & Nitrite	0.5 ug-at/l	@20 ug-at/l
Nitrite	0.02 ug-at/l	@0.3 ug-at/l
Silicate	0.25 ug-at/l	@10 ug-at/l
Ammonia	0.1 ug-at/l	@10 ug-at/l
Phosphate	0.1 ug-at/l	@1 ug-at/l
Ortho-phosphate	0.03 ug-at/l	
Total Phosphate	0.1 ug-at/l	@3 ug-at/l
Alkalinity	.02 milliequivalents/l	
Residual Chlorine	.05 mg/l	
Biological Pigments		
Chlorophyll ā	0.26 ug	
Phaeophytin	0.05 ug	@0.5 ug
Dissolved Organic Carbon	0.06 mg/l	
Particulate Organic Carbon ("oxidizable carbon")	120 mg	@800 ug
ATP	3 ng/l	@50 ng/l
Oil and Grease	0.9 mg/l	
Primary Productivity	3 mgC/m3 incubation	@25 mgC/m3 for 5 hr.
Particulate Iron	0.5 mg/l	
Soluble Iron	2 ug-at/l	@42 ug-at/l
Copper	0.1 mg/l	@100 ug/l
Aluminum	0.1 ug/l	
Zinc	1 ng/l	@25 ng/l
Tin	0.2 ng/l	@8.6 ng/l
Chromium	60 ng/l	@300 ng/l
Cobalt	2.3 ng/l	@35 ng/l
Nickel	19 ng/l	@300 ng/l
Eadmium	1 ng/l	@30 ng/l
Titanium	0.9-1.8 ug/l	
Manganese	0.01 ug/l	

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