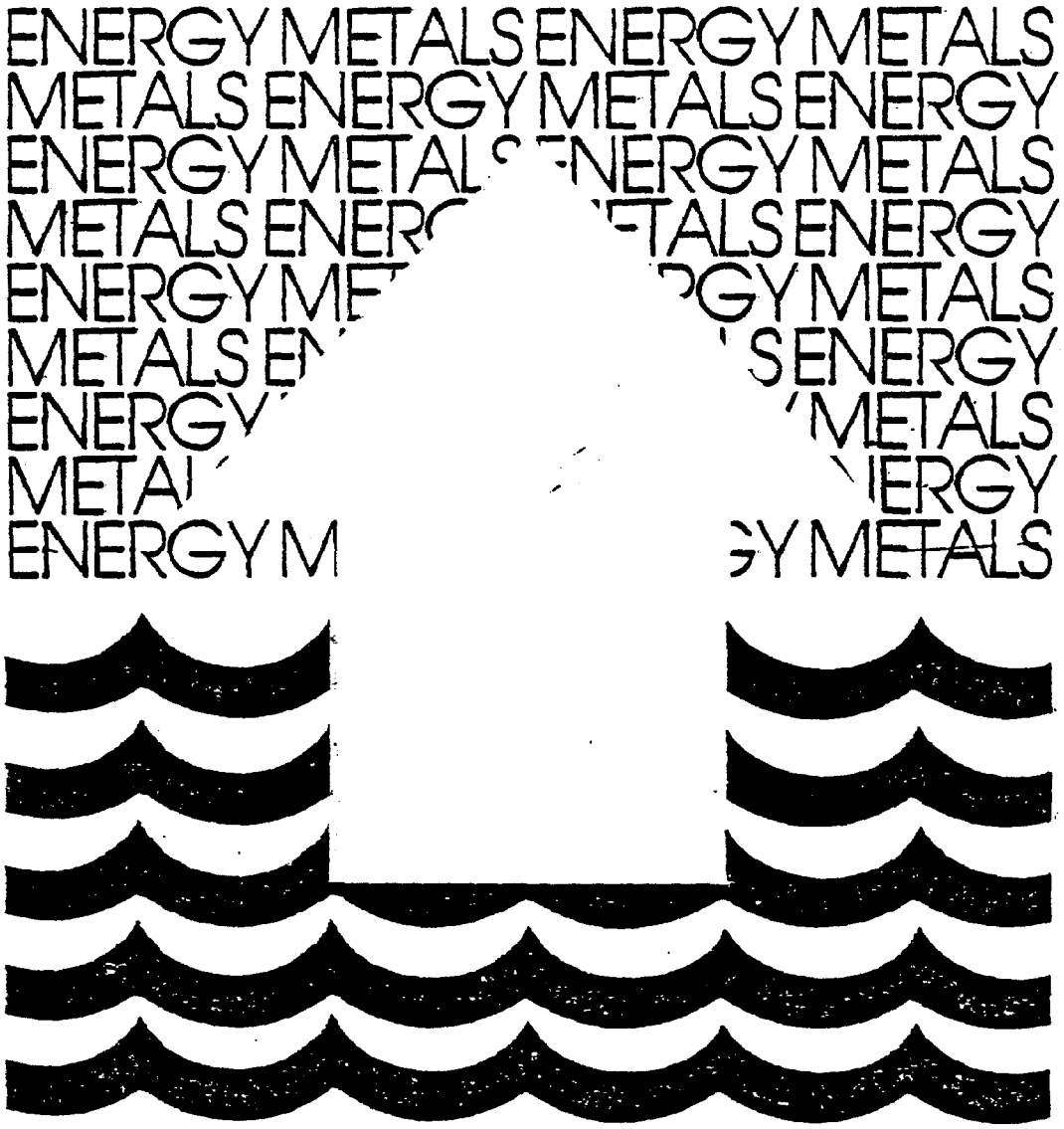

Ocean Thermal Energy Conversion

Final Regulatory Impact Analysis
Final Regulatory Flexibility Analysis

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

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Final Regulatory Impact Analysis

and

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for

Regulations to Implement

Public Law 96-320,

The Ocean Thermal Energy Conversion Act of 1980

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Table of Contents

	Page
I. INTRODUCTION	1
II. BACKGROUND	2
A. OTEC Technology	2
B. Expected OTEC Industry, Benefits and Costs	4
C. Legislative Background	12
D. Regulatory Background	14
E. Summary of Issues Raised by Public Comments	15
III. REGULATORY PROBLEM AREAS	17
Problem 1. General Regulatory Approach	17
A. Statement of the Problem	17
B. Alternative Approaches and Their Consequences	18
C. Selection of Preferred Alternative	27
Problem 2. OTEC Site Evaluation and Preconstruction Testing Activities	28
A. Statement of the Problem	28
B. Alternative Approaches and Their Consequences	29
C. Selection of Preferred Alternative	31
IV. IMPACT ON SMALL ENTITIES	32

Figures

Figure 1. OTEC Commercialization Schedule	6
Figure 2. OTEC Deployment Scenario for Year 2000	7
Figure 3. OTEC Producer Requirements, Plant and Material	11
Figure 4. Cumulative OTEC Producer Investment Distribution	11

Final Regulatory Impact Analysis
and
Final Regulatory Flexibility Analysis

for Regulations to Implement
Public Law 96-320

The Ocean Thermal Energy Conversion Act of 1980

I. INTRODUCTION

The regulations discussed in this analysis implement Public Law 96-320, the Ocean Thermal Energy Conversion (OTEC) Act of 1980, by establishing a regulatory system which will permit and encourage commercial development of OTEC technology.

The National Oceanic and Atmospheric Administration (NOAA) has prepared this Final Regulatory Impact Analysis of the regulations as part of its compliance with Executive Order 12291, which was issued by President Reagan on February 17, 1981. The Executive Order requires preparation of a Regulatory Impact Analysis containing information on potential benefits and costs in connection with every major rule. NOAA has determined that the OTEC regulations are major under the definitions contained in the Executive Order.

NOAA has combined with the Final Regulatory Impact Analysis required by the Executive Order the Final Regulatory Flexibility Analysis required by the Regulatory Flexibility Act (Public Law 96-354) concerning the effect of the regulations on small entities.

A preliminary version of this document was issued on March 30, 1981. Public comments were solicited, and this final document reflects consideration of the comments received. A discussion of the comments is contained in section II.E. of this document.

II. BACKGROUND

A. OTEC Technology

Ocean thermal energy conversion (OTEC) is a renewable process for using solar energy stored in the warm surface waters of the tropical and subtropical oceans to perform useful work. This may be generating electricity for domestic and industrial consumption, or providing energy for industrial refining and manufacturing activities. Several different techniques have been considered as the basis for OTEC power generation. Two of these, closed cycle and open cycle, are believed to hold the greatest promise of being economically viable and technically feasible in the foreseeable future.

The closed cycle technique employs a working fluid (most likely ammonia) enclosed in a system of piping. This fluid is exposed across a heat exchanger surface to oceanic surface waters that have been warmed by the sun. This vaporizes the working fluid causing it to pass through and drive a gas turbine. This produces rotary motion that is used to drive an electric generator and so to produce electricity for distribution to industrial and residential users, or for use directly on site to power energy-intensive processing or manufacturing activities. After passing through the turbine, the working fluid is returned to the liquid phase by exposure in a heat exchanger to cold water drawn from the deep ocean. The working fluid is then revaporized by being pumped back through the warm water heat exchanger, and the cycle is repeated. This means of power generation does not use any fuel. It is based on the repeated vaporization and condensation of the working fluid that is made possible by taking advantage of the temperature difference between the sun-heated surface waters and the perpetually cold deep waters of the tropical oceans. Even the pumps used to draw in the warm and cold water do not need conventional fuel as

they are powered by a part of the energy produced by the process itself.

The open cycle system is, in most ways, quite similar to the closed cycle system. However, in the open cycle system the seawater itself is the working fluid. Warm surface water is pumped into an evaporator in which the pressure is reduced to the point where the seawater boils. This produces steam which passes through and drives a steam turbine which produces electricity or other usable energy as in the closed system. After leaving the turbine, the steam is cooled and condensed by exposure to cold, deep water in a heat exchanger. The open cycle technique has the advantage that the dissolved salts do not accompany the surface water when it forms steam. Thus, a valuable byproduct, fresh water, results when this steam condenses.

The earliest commercial applications of the OTEC principle are expected to use the closed cycle process. There is also, however, considerable interest in open cycle applications because of the additional benefit of fresh water production.

Generation of electricity is expected to be the first commercial application of the OTEC process, with early commercial plants beginning operation by the mid 1980s. This will probably be from facilities which are moored to or mounted directly on the ocean floor, or located partly on land with their intake and discharge pipes extending out into the ocean. The electricity from moored or bottom-mounted facilities will be brought to shore by submarine electrical transmission cables. OTEC facilities located partly on land could be located in areas where deep water is found very close to shore; such sites exist in Hawaii, Guam, and other U.S. islands. OTEC facilities are expected to vary in size from about 10 megawatts (a size suitable for small islands) to about 400 megawatts (about half the size of a large nuclear power plant).

Another possibility for the implementation of the OTEC process is to

use the OTEC energy directly on the site. It could be used for production of energy-intensive products, such as hydrogen or ammonia, or for energy-intensive processing activities, such as aluminum smelting.

Such onsite manufacturing or processing could take place on facilities situated on or close to shore, or on roving plantships. For the facilities near shore, the product would be moved ashore by a product pipeline or by vessels. Self-contained plantships that would use OTEC techniques to obtain the energy needed to run onboard manufacturing or processing activities could float unmoored or move slowly under their own power as they sought out and followed optimum thermal gradient conditions. Vessels would be used to transport OTEC plantship products to their destinations. Such plantships are expected to employ closed cycle systems. Ammonia will probably be the first product produced on OTEC plantships; commercial OTEC ammonia plantships are expected to begin operation in the late 1980s.

B. Expected OTEC Industry, Benefits and Costs

The potential benefits to society from development of a U.S. commercial OTEC industry are expected to far outweigh the potential costs. The major benefits are:

1. a new source of energy competitive with imported oil,
2. major new U.S. export opportunities,
3. alternative means for production of energy-intensive products, and
4. major expansion opportunities for other sectors of the U.S. economy.

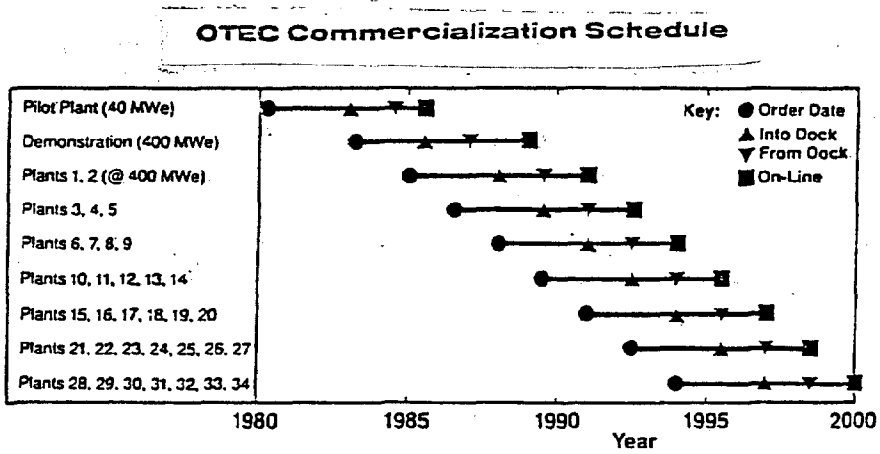
The amount of ocean thermal resource available to be used by OTEC plants is huge. The OTEC process needs temperature differences of 20° Centigrade or more between warm surface and deep ocean waters to operate on an efficient basis. Ocean temperature gradients meeting this requirement at depths of

1,000 meters or less are found in areas of the ocean between latitudes 30° North and 25° South. Estimates of the total ocean thermal energy base range from 100 million to 10 Billion megawatts thermal. An excellent resource base exists in the Western Pacific Ocean, the Caribbean area, the tropical west and southeastern coasts of the Americas, the Indian Ocean, and near both coasts of Africa. Potential areas of deployment for the United States include Guam, American Samoa, other Western Pacific islands, Hawaii, Puerto Rico, the U.S. Virgin Islands, and the Gulf of Mexico. The total ocean thermal resource within 200 miles of the United States is estimated as about equal to total present U.S. energy usage.

The earliest commercial deployments are expected to occur at sites where an acceptable thermal gradient is available near to shore at a depth of 500 meters or less, and where electricity costs are extremely high. Most U.S. islands which depend almost entirely on imported oil for generation of electricity have such possible OTEC sites, and they are expected to be the location of the first commercial U.S. OTEC facilities.

A goal has been set of installation of 10,000 megawatts of U.S. OTEC capacity by 1999. Several scenarios have been developed to show how this goal could be met. Two of those scenarios are summarized in figures 1 and 2. Each scenario shows U.S. deployment of 14,000 megawatts electric in OTEC capacity by the year 2000. Other scenarios project greater U.S. deployment of OTEC facilities and plantships, with the highest scenario projecting deployment of 39,000 megawatts of OTEC capacity by 1999. The House of Representatives Committee on Merchant Marine and Fisheries estimated in its report on the legislation which became the OTEC Act of 1980 (H. Rept. 96-994, p. 25) that OTEC could provide from 5 to 20 percent of all new electrical generating capacity coming on line in the

FIGURE 1



from Paul A. Curto and Robert Cohen, "Producer Incentives for OTEC Commercialization," Proceedings, 7th Ocean Energy Conference, 1980

U.S. by the year 2000 if the OTEC program is successful and is aggressively pursued. Use of OTEC would become that extensive only if--as predicted--OTEC electricity is cost-competitive with electricity generated from oil, coal, and nuclear power plants. Recent Department of Energy evaluations give a projected cost for OTEC-generated electric power and stored chemical energy in 1990 and beyond which is competitive with costs for power or products from coal, fossil fuel, and nuclear sources. If current construction cost estimates are accurate, OTEC electricity is now competitive with electricity generated from imported oil on U.S. islands. Based on current economic analyses and projected market conditions, the Department of Energy predicts that island baseload electricity will cost 130 to 230 Mills/KWh_e (in 1980 dollars) by 1995; using today's technology, OTEC can generate electricity at a cost of 100 Mills/KWh_e (in 1980 dollars). The use of this less expensive electrical generation technology would enable residents and businesses to avoid rising electricity costs caused by continuing increases in the price of fuel, and would assure a continuous source of reasonably-priced electricity

FIGURE 2

OTEC DEPLOYMENT SCENARIO FOR YEAR 2000

Region	Plant Type	Plant Size (MWe)	Number of Plants	Total Output (GWe)	Percent of Total Projected Need*
		BASELOAD ELECTRICITY			
Gulf of Mexico	Closed-cycle	400	5	2.0	<1
Puerto Rico	Closed-cycle	(400, 100, 40)	4	0.94	
	Open-cycle	40	2	0.08	
	SUBTOTAL-PUERTO RICO		6	1.02	20
Virgin Islands					
St. Croix	Closed- or Open-cycle	40	2	0.08	70
St. Thomas	Closed- or Open-cycle	40	2	0.08	70
	SUBTOTAL-VIRGIN IS.		4	0.16	70
Hawaii					
Oahu	Closed-cycle	400	2	0.8	40
Hawaii	Closed- or Open-cycle	100	1	0.1	50
Kauai	Closed-cycle	40	1	0.04	50
Maui, Lanai, and Molokai	Closed- or Open-cycle	40	2	0.08	50
	SUBTOTAL-HAWAII		6	1.02	40
Guam	Closed- or Open-cycle	40	3	0.12	40
Northern Marianas Islands	Closed- or Open-cycle	10	1	0.01	60
	BASELOAD TOTAL		25	4.33	
		AMMONIA PLANTSHIPS			
Gulf of Mexico	Closed-cycle	500	9	4.5	-
South Atlantic	Closed-cycle	500	9	4.5	-
	TOTAL AMMONIA PLANTSHIPS		18	9.0	
		ALUMINUM PLANTSHIPS			
Gulf of Mexico	Closed-cycle	400	1	0.4	-
South Atlantic	Closed-cycle	400	1	0.4	-
North Pacific	Closed-cycle	400	1	0.4	-
	TOTAL ALUMINUM PLANTSHIPS		3	1.2	
	GRAND TOTAL		46	14.53	

*Calculated by multiplying current per capita electricity usage by the population projected for the year 2000.

from Draft Environmental Impact Statement on Regulations to Implement the OTEC Act of 1980

in future years.

If ten thousand megawatts of OTEC capacity replaced the use of imported oil for electricity generation the resulting impacts (assuming OTEC operation at 90% of capacity) would be reduction of oil imports by 360,000 barrels per day and reduction of U.S. import costs (at $35 per barrel) by $4.6 Billion per year. Preliminary studies conducted for the Department of Energy indicate that installation of 10,000 Mw of OTEC generating capacity by 1999 could displace a cumulative total of $18 Billion spent on imported oil by that year.

An econometric study based on an OTEC development scenario similar to that of Figure 1 projects that by 1997 construction of OTEC plants could generate the following annual economic effects (Dr. James R. Roney, "Employment and Economic Impacts of OTEC Commercialization," March, 1981):

- o employment of 144,000 workers, 60,000 of them at shipyards or other OTEC plant construction sites
- o personal income from construction activities (and multiplier effect) of $3.9 Billion
- o retail sales from construction salaries (and multiplier effect) of $1.2 Billion
- o local and state taxes of $180 million
- o Federal income taxes of $600 million.

Once U.S. companies have demonstrated the commercial viability and dependability of OTEC technology at U.S. islands, they could begin to develop export markets for U.S.-built OTEC plants, in addition to continuing to deploy OTEC plants for domestic use. Japan, France, Sweden, the Netherlands, and several other countries are working with OTEC technology, but at the present time the United States has a slight technological lead. Japan has already sold an OTEC plant to the island nation of Nauru.

The potential for export of U.S.-built OTEC plants can only be described as vast. Approximately 70 countries and territories--many of them lesser

developed countries now dependent on imported oil—are located within 200 miles of usable OTEC resource. When the added electric power generation needs of these countries between the years 1990 and 2010 are examined, the potential export markets for which U.S.-built OTEC plants could compete are found to be able to accommodate on the order of 100 10 Mw plants, 500 40 Mw plants, 1100 100 Mw plants, and 1100 400 Mw OTEC plants. Even if U.S. companies are able to supply only ten percent of this potential market, U.S. exports of OTEC plants during those years would amount to a capital investment of about $171 Billion (1980 dollars) and would have major beneficial effects on U.S. employment and trade balances and in reducing worldwide dependence on oil. The $171 Billion capital investment in OTEC would result in an estimated cumulative displacement of $343 Billion (1980 dollars) of imported oil by the year 2010 (Lyle E. Dunbar, "Market Potential for OTEC in Developing Nations," 8th Ocean Energy Conference, June 1981).

The first commercial use of OTEC is expected to be for generation of electricity for distribution through normal electric company power grids. However, either stationary OTEC platforms or moving plantships could use OTEC electricity on site to make hydrogen or ammonia (NH_3). Hydrogen would be produced by electrolysis from seawater, and nitrogen for ammonia production would be obtained by separation from air. Because hydrogen is extremely flammable, it can be shipped more safely over long distances when combined with nitrogen as ammonia.

OTEC ammonia is expected to be used in production of fertilizer, and as a means of transporting hydrogen to large fuel cells which would reconvert it to electricity. Ammonia is the principal source of nitrogen for fertilizer. Current ammonia production typically uses natural gas both as a raw material and for process heat. In 1978 approximately 3% of the natural gas produced in the United States (an amount approximately equal to the

total residential use of natural gas in California) was used to make ammonia. The substitution of OTEC ammonia for ammonia made from natural gas could conserve the equivalent of 300,000 to 500,000 barrels of oil per day.

Some U.S. ammonia producers are obtaining the natural gas they use under long-term contracts under which they pay as little as $.17 per 1,000 cubic feet. The average price being paid for natural gas used in ammonia production is estimated as $.85 per 1,000 cubic feet, compared to a new-contract price of well over $2.00. With oil at $35 per barrel, the Btu equivalent price of natural gas would be $6.03 per 1,000 cubic feet. As the ammonia producers' long-term contracts for natural gas expire and they begin to have to pay current prices for natural gas, the $150 per ton price of ammonia produced from natural gas could easily triple or quadruple. The availability of OTEC ammonia—which will not depend on natural gas—will help to put a ceiling on the price of ammonia, and will temper the fertilizer cost increases which would otherwise create financial difficulties for farmers and cause tremendous inflation in the price of food.

New types of fuel cells which can convert hydrogen to electricity are now being developed and tested. Such fuel cells could use the hydrogen from OTEC ammonia to generate baseload power at any location to which the ammonia could be transported. Transport of ammonia could serve as a substitute for use of high-voltage transmission lines to bring electricity to remote or hard-to-reach areas. Because the fuel cells would produce no pollution as by-products—only heat and water—large banks of them could eventually be used to produce electricity for cities suffering severe air pollution problems.

Construction of 10,000 megawatts of installed U.S. OTEC capacity by the year 1999 will stimulate significant increases in manufacture of materials

FIGURE 3

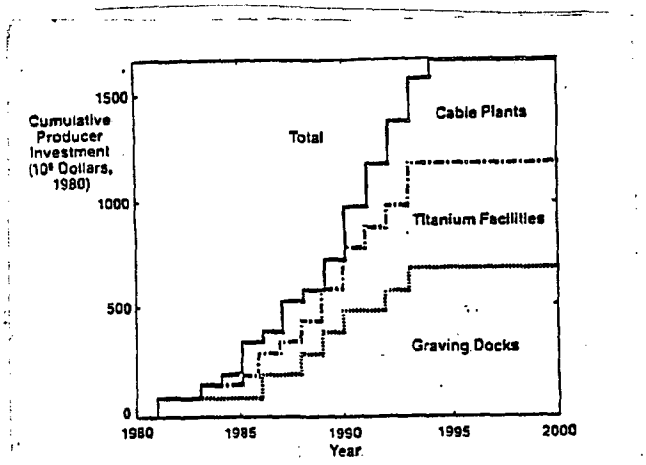
OTEC PRODUCER REQUIREMENTS, PLANT AND MATERIAL

Year	OTEC Plant Capacity (MWe)	OTEC Titanium Requirements (Short Tons)	OTEC Cable Requirements (Miles)	OTEC Graving Dock Requirements (Number in Service
1981	0	0	0	0
1982	0	0	6	1
1983	0	3000	0	1
1984	40	0	0	1
1985	40	0	0	1
1986	40	5000	80	1
1987	40	5000	80	1
1988	40	10,000	160	2
1989	440	10,000	160	3
1990	440	15,000	240	3
1991	1240	15,000	240	4
1992	2440	20,000	320	5
1993	2440	30,000	480	5
1994	4040	40,000	640	6
1995	6040	40,000	640	7
1996	6040	50,000	800	7
1997	8440	50,000	800	7
1998	11,240	50,000	800	7
1999	11,240	50,000*	800*	7*
2000	14,040	50,000*	800*	7*

* 10,000 ST Titanium and 160 miles of cable in 1999 are used for plants coming on-line by 2000; the amounts indicated for 1999 and 2000 above this level are for plants to be on-line post-2000.

FIGURE 4

Cumulative OTEC Producer Investment Distribution



from Paul A. Curto and Robert Cohen, "Producer Incentives for OTEC Commercialization," Proceedings, 7th Ocean Energy Conference, 1980

and components used in OTEC plants. Curto and Cohen used their development scenario (figure 1) to estimate the increased facilities which would be needed in three sectors--titanium, submarine electric cables, and shipyard graving docks--to handle the projected OTEC business. Their estimates of the new business in these three areas are listed in Figure 3, and their estimate of new physical plant construction in those sectors to handle the new business is presented in Figure 4. Curto and Cohen assumed that titanium will be the material of choice for OTEC heat exchangers. However, assessment of heat exchangers made of aluminum alloys is proceeding. It is expected that the primary heat exchanger material in most commercial OTEC plants will be aluminum.

The projections of Curto and Cohen for only three aspects of OTEC plant

construction serve as examples of the massive expansion opportunities which development of a commercial OTEC industry will present for the U.S. economy. Their projections of the opportunities for economic expansion are actually quite conservative, since the OTEC development scenario on which their projections were based did not include any construction of OTEC plants for export to other countries.

The net environmental impacts due to commercial development of OTEC are expected to be minimal compared to the impacts of nuclear and fossil-fueled electricity generation; however, there are uncertainties associated with the movement of large volumes of ocean water that must be better assessed.

Development of a commercial OTEC industry will cause some economic dislocations, primarily in sectors involved in construction of other types of power plants and delivery of forms of energy which are more expensive than OTEC energy. For many companies, such as those who manufacture turbines for conventional electrical generation or build tankers to transport oil, the market opportunities lost because of the new OTEC industry will be replaced by opportunities to participate in the OTEC industry. Suppliers of oil and natural gas may suffer gradual changes in their delivery patterns and reductions in projected demand as increasing numbers of OTEC plants begin operation. These negative economic impacts are expected to be several orders of magnitude smaller than the economic benefits of emergence of a large and vital commercial OTEC industry.

C. Legislative Background

The Ocean Thermal Energy Conversion Act of 1980 (OTEC Act) was passed by the Congress during the summer of 1980, and was signed into law on August 3, 1980. The primary purpose of the Congress in passing the new law was to establish a legal and regulatory framework to permit and encourage development

of a commercial OTEC industry.

After testimony from industry and other witnesses, the Congress concluded that without passage and implementation of the OTEC Act of 1980, legal and regulatory barriers would prevent U.S. companies from building and operating commercial OTEC plants. The institutional barriers addressed by the Act consisted primarily of uncertainty about legal and regulatory matters which—if not addressed in specific legislation and regulations—would cause potential investors to place too high a risk on investment in OTEC operations, and to refrain from investing in them.

The legal and regulatory uncertainties which would have prevented investment in OTEC operations included:

1. Lack of any clear statement that OTEC activities are legal under national or international law;

2. Lack of any law or regulation assuring continued access to the ocean thermal resource being used by a particular OTEC plant;

3. Lack of clarity as to whether admiralty, land-based, or some other body of residual and common law would apply to activities on OTEC platforms located on the high seas beyond the normal coverage of national laws;

4. Absence of certainty that OTEC operations would not be declared illegal or partially restricted in the future by national laws or international treaties; and

5. Lack of clarity as to which federal agency regulations might apply to OTEC operations in U.S. waters, and how those regulations which might apply would be interpreted when applied to OTEC operations.

Legal and regulatory uncertainties such as those enumerated above would have made it impossible to guarantee a potential investor the return of his capital, no matter how great the potential profits of the OTEC project appeared to be. Consequently, potential OTEC owners would have found it extremely difficult, if not impossible, to obtain loans or other financing. The absence of a clear legal status for OTEC plants would also have made it either very

difficult or impossible to obtain insurance for an OTEC plant. The officers of a public corporation might even have been accused of violating their fiduciary trust to their stockholders by taking undue risks if they committed corporate funds to an OTEC venture.

The OTEC Act accomplishes its primary purpose by establishing United States jurisdiction over OTEC facilities located in the U.S. territorial sea or connected to the United States by pipeline or cable, OTEC facilities or plantships documented under U.S. laws, and OTEC plantships owned or operated by U.S. citizens; specifying which federal and State laws apply to OTEC facilities and plantships under U.S. jurisdiction; and establishing a fair and expeditious licensing system which will insure compliance of U.S. OTEC facilities and plantships with both U.S. and international law. The license processing system specified in the Act will produce a single decision representing all involved federal agencies without the protracted delays which sometimes occur in other governmental licensing processes. The licensing system is to be administered by NOAA, and is the primary subject of the regulations discussed in this document. The Act also contains several provisions relating to financing of OTEC facilities and plantships; those provisions are to be implemented by the Maritime Administration of the Department of Commerce, and are not included in the NOAA regulations.

D. Regulatory Background

There are at present no regulations which specifically apply to OTEC operations. No existing regulations of any federal agency specifically state whether or not they apply to commercial OTEC activities. Some agency regulations, such as the Environmental Protection Agency's National Pollutant Discharge Elimination System and ocean discharge regulations, apply to narrow aspects of OTEC operations. In most cases, however, it is not clear whether

or not existing regulations apply to commercial OTEC operations. This rulemaking delineates clearly which existing federal agency regulations will apply to commercial OTEC activities, and establishes a licensing system which will fully implement the legal and regulatory framework which must be in place before commercial OTEC operations can commence. Issuance of the regulations is required by section 102(a) of Public Law 96-320, the Ocean Thermal Energy Conversion Act of 1980.

In order to encourage public participation in the preparation of the proposed regulations, NOAA published an Advance Notice of Proposed Rulemaking in the November 21, 1980 edition of the Federal Register (45 Fed. Reg. 77,038 (1980)). That notice listed some of the important issues involved in the rulemaking and invited oral or written comments. A number of such comments were received and analyzed, and a public hearing to receive comments on the issues involved in the rulemaking was held on January 7, 1981. Based on the comments received, NOAA refined the regulatory alternatives for discussion of them in the preliminary version of this document, and issued a Notice of Proposed Rulemaking in the March 30, 1981 edition of the Federal Register (46 Fed. Reg. 19418 (1981)). The final regulations and this document reflect public comments received at three public hearings or in writing.

E. Summary of Issues Raised by Public Comments

In response to the Notice of Proposed Rulemaking which was accompanied by release of the preliminary version of this document, NOAA received testimony at three public hearings and a number of written comments. While none of the oral or written comments were specifically directed to the Preliminary Regulatory Impact Analysis/Initial Regulatory Flexibility Analysis, a number of comments contained statements regarding NOAA's general approach in the Notice of Proposed Rulemaking.

All of those comments except one supported NOAA's selection of the "minimum regulation" general approach as the approach which will best permit the innovation and flexibility necessary in the early years of implementation of a new technology.

One comment suggested that if the minimum regulation alternative is to be implemented, "this concept should only be used once our predictive ability as regards to environmental impact has been refined. It would seem appropriate to proceed with caution and apply the detailed regulation approach in the initial stages of development of OTEC, such as the deployment of a pilot plant. Furthermore, this approach should be closely coupled to an appropriate research program of sufficient breadth and scope. The research program should be generic in nature, but tailored to the particular characteristics of the site."

NOAA notes that this comment relates more directly to the manner in which NOAA acts while considering individual site-specific license applications than to the contents of the generic licensing regulations. NOAA continues to believe that the inclusion of detailed substantive provisions or guidelines and performance standards in the generic licensing regulations is undesirable at this early stage of OTEC technology because such requirements would limit technology development and because it would be very difficult to justify such requirements with the existing knowledge base. For these reasons NOAA did not change its choice of preferred general approach.

A number of comments which agreed with NOAA's selection of the "minimum regulation" general approach went on to suggest specific changes in the proposed regulations to better implement that approach. NOAA has adopted those suggested changes where it was possible to do so. A complete description of those suggestions and changes is contained in the preamble of the Notice

of Final Rulemaking.

No comments specifically addressed NOAA's choice of the "no regulation" alternative on OTEC site evaluation and preconstruction testing activities, or the discussion of impact on small entities. NOAA has made several changes in the section of this document entitled "Expected OTEC Industry, Benefits and Costs" in order to include the latest available data estimating the potential impacts of OTEC.

III. REGULATORY PROBLEM AREAS

PROBLEM 1. GENERAL REGULATORY APPROACH

A. Statement of the Problem

Regulations are necessary to complete establishment of a legal regime which will reduce legal and regulatory barriers to construction of commercial OTEC facilities and plantships. Reduction of those institutional barriers was the primary purpose of the Congress in passing the OTEC Act of 1980. 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 insure that one OTEC plant does not interfere with the ocean thermal resource used by another OTEC plant;
3. to protect the marine and coastal environment; and
4. to insure that commercial OTEC facilities and plantships licensed by NOAA comply with international treaty obligations of the United States.

No OTEC plant of commercial size has yet been constructed or operated. Many theoretical predictions have been made of the operating characteristics and impacts of commercial OTEC plants, but the theoretical work has not been confirmed by actual experience. Consequently, NOAA has devised a general approach to its regulatory responsibilities which takes into account the

possibility of unexpected operating characteristics or impacts while meeting the legislated goals for the regulatory system.

B. Alternative Approaches and Their Consequences

NOAA considered four possible general approaches to the regulations: (1) detailed regulation of OTEC activities, (2) moderate regulation of OTEC activities, (3) minimum regulation of OTEC activities, and (4) no regulations. Each of these alternatives is discussed below.

1. Detailed regulation of OTEC activities.

In this general approach the regulations would contain detailed substantive provisions specifying design of OTEC plant components and requiring use of specific operating procedures. The substantive provisions of the regulations might include detailed design specifications for screens on warm and cold water intakes, specification of the geometry of discharge outlets, detailed design criteria for valves and controls to prevent discharge of working fluid into the environment, and detailed specification of operating procedures for biofouling control. NOAA would have to conduct detailed reviews of all aspects of the proposed OTEC plant--including its design--in order to determine full compliance with the detailed regulations. The information required to be submitted with an application would have to be voluminous, and the level of plant design detail required would necessitate completion of detailed design of the proposed OTEC plant prior to preparation of the license application for submission to NOAA. Prospective OTEC plant owners would have to complete detailed plant design and make major expenditures of time, personnel and funds to prepare their applications. NOAA would have to hire a sizable staff and expend substantial sums to analyze an application, make the many detailed determinations required by the regulations, and perform the other tasks necessary to process the application.

Under this approach the administrative costs for processing an application are estimated at $1 million, and the license processing fee paid by the applicant to cover reasonable administrative costs would be $1 million.

In addition, a licensee would have to keep detailed records and submit detailed reports to NOAA to demonstrate compliance of the OTEC plant operations with diligence requirements and all of the other specific requirements contained in the regulations. Records would have to substantiate adherence to each specific plant design and operating requirement contained in the regulations, and reports demonstrating compliance would be required at the end of every month. The monitoring of environmental effects which the licensee is required to perform by section 110(3) of the OTEC Act would provide NOAA information needed to determine whether some of its detailed regulatory requirements were stricter than necessary to accomplish the regulatory goal. Those regulatory requirements found to be more strict than necessary would then be relaxed.

This detailed regulation approach has two major disadvantages: (1) it would require a large and expensive administrative apparatus, and (2) it would not allow the design flexibility needed for technological development. Use of this approach would require NOAA to specify uniform detailed design requirements now on aspects of OTEC plant design which have not been fully resolved from the engineering standpoint, and of which the full consequences --either environmental or economic--are not yet known. An inevitable result of attempting to write such detailed requirements from the current lack of specific knowledge would be that the regulations would restrict engineering and design options without demonstrable public benefit from the detailed regulatory requirements. The effect of this specific problem, added to the burdensome nature of the entire regulatory process under this

alternative, would most certainly be to deter potential OTEC owners and discourage commercial development of OTEC technology--a result directly opposite the result intended by the Congress in passing the Act. Adoption of this alternative would provide a low probability of obtaining the benefits to society from OTEC development, with the highest costs to potential OTEC owners and the government. For that reason, the detailed regulation alternative was not seriously considered.

2. Moderate regulation of OTEC activities.

In the moderate regulation approach the regulations would not contain detailed substantive provisions specifying design of OTEC plant components or plant operating procedures. The regulations would, however, contain detailed guidelines and performance standards applicable to all OTEC facilities and plantships in order to insure adherence to the overall regulatory goals. A license applicant would be required to prove that his plant design and approach will meet each of the detailed guidelines and performance standards included in the regulations. Guidelines and performance standards might relate to such matters as degree of entrainment through warm water intakes, discharge plume direction and velocity, and concentrations of chemicals in discharge water. The plant design information required to be submitted with an application would be less voluminous than for alternative 1, but would have to include analyses and predictions of the proposed OTEC plant's performance characteristics and impacts in areas covered in the guidelines and performance standards. While this alternative would not require submission of a detailed design for the entire proposed OTEC plant, the information needed to demonstrate compliance with at least some of the guidelines and performance standards would probably not be available until at least part of the OTEC plant detailed design is completed. Prospective OTEC plant owners would have to make major expendi-

tures of time, personnel and funds to prepare their applications, although these expenditures would not be as large as in alternative 1. NOAA would have to hire approximately 12 people and expend an estimated $700,000 to analyze each application, determine whether or not the applicant had demonstrated compliance with each of the specific guidelines and performance standards, and perform the other tasks necessary to process the license application. Under this approach the administrative costs to NOAA for processing an application would approximate $700,000, and the license processing fee charged to the applicant to cover reasonable administrative costs would be set at that amount.

A licensee would be required to keep substantially more detailed records than kept in the normal course of business, and to submit periodic reports to NOAA to demonstrate compliance with the diligence and other specific guidelines and performance standards. The records would have to substantiate compliance with each of the specific plant performance standards and guidelines, and reports demonstrating compliance would be required either monthly or quarterly. The monitoring of environmental effects which the licensee is required to perform by section 110(3) of the OTEC Act would provide NOAA information needed to determine whether some of its detailed guidelines and performance standards were stricter than necessary to accomplish the regulatory goals, and would alert NOAA to additional areas in which specific guidelines or performance standards were needed.

This moderate regulation approach has two disadvantages: (1) it requires a relatively large administrative apparatus to develop performance standards and determine compliance with them, and (2) it would limit engineering flexibility more than necessary to meet the regulatory goals at some potential OTEC sites. Use of this approach would result in NOAA establishing uniform guidelines and performance standards applying to all

OTEC plants, regardless of specific design or location. In some cases, the uniform guidelines and performance standards would restrict design options which might be preferred from an engineering standpoint for a particular OTEC plant or site. A given performance standard might be stricter than necessary for the conditions present at one OTEC site, while not strict enough for the conditions present at another OTEC site. The full consequences of such a result would not be known at the time NOAA adopted the original set of guidelines and performance standards because there is no real-world experience with OTEC plants of commercial size on which to rely in the establishment of guidelines and performance standards.

The use of specific guidelines and performance standards is a common approach to regulation of relatively mature and stable industries where many facilities already exist and the nature of the technology used in them and its impacts are well known. However, when applied to a nascent industry such as OTEC this approach could have a limiting effect on the flexibility and experimentation which will be necessary to learn the designs which best meet the combined goals of sound engineering, economic construction and operation, and protection of societal values. Because another alternative is more suitable to the current early developmental stage of the OTEC industry and would provide a greater probability of obtaining the benefits to society from development of OTEC technology at less cost to potential OTEC owners and the government, this alternative was not selected.

3. Minimum regulation of OTEC activities.

Under the minimum regulation alternative NOAA would put in its regulations only the general guidelines and performance standards specified in the OTEC Act of 1980. Detailed guidelines and performance standards would not be prescribed in advance in regulations, but would be included in

the terms and conditions of a license if they were deemed necessary by the Administrator 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 would require NOAA to examine each applicant's assessments of the nature and relative magnitude of each type of problem which might occur as a result of construction and operation of the proposed OTEC plant. Only those problems which appeared to be significant would be analyzed in detail. The information submitted to NOAA in a license application would need to include details of the proposed site, descriptions of the operating features of the plant, and assessments of the potential impacts of construction and operation; however, plant design information submitted would not be as extensive as in alternatives 1 or 2, and would not include detailed engineering designs for the proposed plant or its components. Prospective OTEC plant owners would have to expend less time and resources in preparation of applications than under alternatives 1 or 2, and could apply for licenses before they had completed detailed design of the proposed plant. NOAA would employ 2 or 3 people to analyze the information submitted and perform the other tasks necessary to process the license application. Under this approach the incremental administrative costs to NOAA for processing each application (including preparation and printing of draft and final environmental impact statements and travel to the proposed site to coordinate licensing decisions with State and local officials and hold the public hearings required by the Act) are estimated at $250,000, and the license processing fee charged to the applicant to cover reasonable administrative costs would be set at that amount.

A licensee would be required to submit periodic reports to NOAA to

demonstrate compliance with license terms and conditions; the frequency and volume of these reports would be substantially less than under alternative 1 or alternative 2. NOAA would normally not require the licensee to keep records other than those usually kept in the normal course of doing business. The monitoring of environmental effects which the licensee is required to perform by section 110(3) of the OTEC Act would alert NOAA to significant problem areas which might need to become the subject of license terms and conditions in the future. The requirement of section 106 of the Act that the licensee pursue diligently the construction and operation of the licensed OTEC plant would be implemented by reference to the licensee's own work schedule, with allowance for unforeseen events and circumstances; this approach will minimize burdens on the licensee while fulfilling the intent of the Act to prevent the holding of OTEC licenses by idle speculators.

Use of this approach would place NOAA in the position of considering and responding to proposals made by license applicants, instead of prescribing standards for the applicant to follow. The flexibility afforded the applicant under this approach would allow the prospective OTEC plant owner to determine what he considers to be the best engineering and cost-effective design for the plant and to design his own cost-effective means of mitigating any adverse environmental impacts from plant operation. The flexibility would facilitate incorporation of new technology into OTEC plant design as the technology is developed. The regulatory system would accomplish the regulatory goals of the OTEC Act of 1980 without interfering with the engineering innovations and responsible experimentation which is part of the development of a new commercial technology in its early years.

This general approach will encourage the emergence of a commercial OTEC industry in the United States by completing establishment of the necessary

legal and regulatory framework, and by allowing the degree of flexibility appropriate for a new industry. It will provide the greatest probability of obtaining the potential benefits to society from OTEC development, at the least possible cost to potential OTEC owners and the government.

4. No regulations.

Under this alternative NOAA would not issue regulations to implement the OTEC Act of 1980.

A decision to not issue regulations would place the Administrator of NOAA in violation of the law (section 102(a) of the OTEC Act requires the Administrator to complete issuance of final regulations by August 3, 1981), and would also result in absolute legal prohibitions against ownership, construction or operation of any OTEC facilities off the coasts of the United States and its territories, and against ownership, construction, or operation of OTEC plantships anywhere in the world by U.S. citizens (since section 101(a) of the OTEC Act prohibits those activities without licenses). There is no known reason why the federal government should prohibit private industry from building and operating OTEC facilities and plantships, and that result would be the exact opposite of the encouragement of private industry intended by the Congress.

Because the "no regulations" alternative would be illegal and make no sense unless Congress were to repeal the regulatory provisions of the OTEC Act, the potential results of repeal were examined. Repeal of the regulatory provisions of the OTEC Act would leave in existence many of the legal and regulatory uncertainities intended by the Congress to be resolved by passage of the Act. No legal rules would exist to protect the thermal resource on which one OTEC plant depends from interference or degradation by other OTEC plants. Without such legal protection for the continued existence of the

resource necessary for economic viability of OTEC operations, financial institutions would have no assurance that the OTEC owner could continuously generate the income necessary to repay the large amounts of financing needed for construction. Private financing would be extremely difficult or impossible to obtain.

In the absence of specific regulatory legislation, many federal agencies would be unsure which of the laws and regulations they administer would apply to OTEC plants. Prospective OTEC owners would have to spend months meeting with each agency to determine the specific regulations which apply, and the ways in which those regulations would be interpreted. A potential OTEC owner could be confronted with a situation in which it would be impossible to design his plant to meet all the separate requirements of agencies with differing narrow responsibilities. The amount of time required for a potential OTEC owner to obtain permission individually from all necessary federal agencies would most certainly exceed the 356-day time limit for a unified federal licensing decision specified in the OTEC Act. One example of the time involved to obtain federal agency permits individually is that it took one year and nine months (October 1978 to July 1980) for the Department of Energy's contractor for the OTEC-1 test platform to obtain all the necessary permits.

If by some chance a potential OTEC owner were willing to persist in the face of the legal and regulatory obstacles and succeeded in financing and building an OTEC plant, there would be no real legal protection against his operating the OTEC plant in a way which would create severe environmental problems or interfere with other OTEC plants, offshore oil and gas drilling activities, major fisheries, or other activities of ocean users.

The United States is a party to international treaties which require

the federal government to insure that its citizens respect the rights of citizens of other counties in conducting ocean activities. The actions of such an OTEC owner without the legal regime specified by the OTEC Act of 1980 could possibly place the United States in violation of its international treaty obligations and create a difficult international incident, in addition to causing economic damage to other ocean industries.

In summary, the no regulations alternative would be illegal and would make no sense unless accompanied by repeal of the regulatory provisions of the OTEC Act of 1980, but repeal would result in higher costs to society than issuance of regulations under alternative 3. Repeal of the regulatory provisions would erect legal and regulatory barriers (discussed on pp. 12-14) which would discourage or prevent development of a commercial OTEC industry, and prevent realization of the full potential benefits to society (including tax revenues to the government) from development of OTEC. The time and cost to a potential OTEC owner for obtaining federal agency permits individually would be greater than the time and cost required under regulations implementing the OTEC Act. If an OTEC industry were to develop despite those barriers, there would be no legal system in place to protect the offshore drilling industry, fishing industry, and other major ocean industries from economic harm caused by OTEC operators, and additional costs would be borne by those industries. For those reasons, NOAA has rejected the "no regulations" alternative.

C. Selection of Preferred Alternative

Alternative 3, minimum regulation of OTEC activities, has been chosen as the preferred general approach, because it offers the greatest encouragement for creation of a commercial OTEC industry and realization of the resulting major economic benefits to the United States. The alternative selected is the alternative which provides the maximum net benefit to society

by encouraging commercial development of OTEC, with the least net cost to both the private and governmental sectors.

PROBLEM 2. OTEC SITE EVALUATION AND PRECONSTRUCTION TESTING ACTIVITIES

A. Statement of the Problem

Section 102(b) of the OTEC Act authorizes the Administrator of NOAA to issue regulations, if he determines them to be necessary, which relate to activities in site evaluation and preconstruction testing at potential OTEC locations that may (1) adversely affect the environment, (2) interfere with other reasonable uses of the high seas or authorized uses of the Outer Continental Shelf, or (3) pose a threat to human health and safety.

Site evaluation and preconstruction testing activities are likely to consist primarily of activities designed to measure oceanic and bottom characteristics, such as currents, sea temperatures, depth of thermocline and pycnocline, types and abundance of biota, ability of the bottom to hold a firm mooring, etc. Such activities might include use of oceanographic research vessels and placement of current meters, thermister chains, and other oceanographic instruments. Techniques to evaluate bottom characteristics for potential mooring areas and cable or pipeline corridors might include grab sampling or small-scale coring and seismic work. Dyes, drogues, and drift bottles might be used to measure site characteristics related to OTEC plant intake and discharge plume behavior. These are types of activities normally conducted during scientific research in the ocean.

Oceanographic research vessel activities and other scientific research at sea are not specifically regulated by the federal government. One reason they are not regulated is that they are not generally regarded as causing adverse effects on the environment, interfering with other reasonable uses of the high seas or authorized uses of the Outer Continental Shelf, or posing a

threat to human health and safety. The possibility of interference between oceanographic research activities and other uses of the high seas and Outer Continental Shelf is reduced by the practice of the Coast Guard of including notice of oceanographic research activities in notices to mariners and fishermen.

B. Alternative Approaches and Their Consequences

NOAA considered three possible approaches to regulation of site evaluation and preconstruction testing activities: (1) detailed regulation of OTEC site evaluation and preconstruction testing activities, (2) regulations requiring prior notice to NOAA of OTEC site evaluation and preconstruction testing activities to be undertaken and reports summarizing the activities and the information obtained, and (3) no regulation of OTEC site evaluation and preconstruction testing activities. Each of these alternatives is discussed below.

1. Detailed regulation of OTEC site evaluation and preconstruction testing activities.

This approach would require NOAA approval prior to commencement of each OTEC site evaluation or preconstruction testing activity. It would provide a strict regulatory guarantee that such activity would not adversely affect the environment, interfere with other high seas or Outer Continental Shelf uses, or pose a threat to human health and safety.

However, this assurance would be obtained at considerable cost to both prospective OTEC owners and the government. Prospective OTEC owners would have to commit personnel time and funds to prepare applications for NOAA's consideration, and would have to delay their planned activities while awaiting a decision from NOAA. NOAA would have to hire additional people to review requests for permission to conduct site evaluation and preconstruction testing

activities, develop environmental assessments, and maintain files of requests received and the actions taken on them. Private companies trying to get an edge on possible competitors in locating excellent OTEC sites would have to inform the government of their interest in particular sites at the earliest stages of their investigations, creating potential problems concerning the protection of valuable privately-generated commercial information.

2. Regulations requiring prior notice to NOAA of OTEC site evaluation and preconstruction testing activities to be undertaken and reports summarizing the activities and the information obtained.

This approach would not require NOAA approval prior to each OTEC site evaluation or preconstruction testing activity, but it would require submission to NOAA of notices describing the activities to be conducted and their potential impacts, and of reports promptly afterward summarizing the activities and the information obtained. It would not provide a strict legal guarantee against occurrence of negative impacts from such activities, but the post-activity reports would alert NOAA to any negative impacts so that regulatory action could be taken to prevent similar negative impacts from occurring in the future.

Prospective OTEC owners would have to commit personnel time and funds to prepare and submit activity reports to NOAA. NOAA would have to hire additional people to analyze reports submitted and maintain them in organized files. These costs to the private and government sectors would be less than the costs of alternative 1, but would still involve a large amount of paperwork and some expense for both sectors. Potential problems with respect to protection of valuable privately-generated commercial information would be similar to those in alternative 1.

3. No regulation of OTEC site evaluation and preconstruction testing activities.

This approach would require no prior approval or notice under the OTEC Act before commencement of OTEC site evaluation and preconstruction testing activities, and no reports to NOAA after conclusion of the activities. Specific aspects of such activities, such as injection of substances into the water or placement of objects which could impede navigation, which are currently regulated by various federal agencies, would have to be conducted in conformance with any requirements imposed by those regulations. Because site evaluation and preconstruction testing activities are expected to be similar in nature and magnitude to oceanographic research activities, no significant adverse impacts are expected. The types of information gathered during these activities may be useful to NOAA (e.g., for preparation of environmental impact statements), but NOAA does not need the information prior to the time an OTEC license application is filed for the site in question.

This approach would not result in any direct costs to either prospective OTEC owners or the government. The "no regulation" alternative on this issue can be adopted legally because section 102(b) of the OTEC Act authorizes, but does not require, issuance of site evaluation and preconstruction testing regulations.

C. Selection of Preferred Alternative

Alternative 3, no regulation of OTEC site evaluation and preconstruction testing activities, has been chosen as the preferred alternative because the possible adverse impacts of OTEC site evaluation and preconstruction testing activities are not expected to exceed the minimal impacts of similar oceanographic research activities, and because it is the least costly alternative to both potential OTEC owners and the government. Any costs which might be borne by other ocean users are expected to be negligible.

Consequently, the "no regulation" alternative on the site evaluation and preconstruction testing issue involves the least net cost to society.

IV. IMPACT ON SMALL ENTITIES

OTEC facilities and plantships will be large projects. The smallest commercial size OTEC facility currently contemplated (10 Mw) is estimated to cost $30-50 million to build. Commercial facilities of this small size could be located at islands such as Key West and some U.S. territories in the Western Pacific Ocean. It is expected that the vast majority of commercial OTEC plants will be in the size range of 40-400 megawatts capacity. Even the smallest OTEC plants in this size range are estimated to cost over $100 million.

Because of the large size and high cost of commercial-sized OTEC plants, it is highly unlikely that a small business concern would be able to put forward enough venture or equity capital and locate enough conventional financing by itself to become the sole owner of a commercial OTEC plant. However, it is possible that small business concerns might join with other companies in joint ventures to own commercial OTEC facilities or plantships. In this case the burden of providing the resources to prepare a license application and comply with the regulatory procedures would be distributed among the joint venturers by their own agreement, and is not expected to fall primarily on the small business concern. It is not feasible to estimate the number of small business concerns which might join such joint ventures.

The primary involvement of small business concerns in development of OTEC will be as contractors or subcontractors to provide materials, parts, or services to the owners of the OTEC facilities and plantships. The large size of OTEC plant construction projects and the large diversity of components used should create greatly expanded opportunities for all types of business

concerns, both large and small. Under the OTEC Act of 1980 a single federal license will cover ownership, construction, and operation of an OTEC facility or plantship under U.S. jurisdiction. This license will normally be obtained by the future owner, or by the systems integration contractor acting on behalf of the owner. The regulations do not place any requirements on suppliers of materials, parts, or equipment. Reporting, recordkeeping, environmental monitoring, or other compliance requirements associated with an OTEC license would directly affect a small business concern only if that concern were hired by the owner or operator of the OTEC plant to fulfill those requirements for him. Under the preferred general regulatory approach (alternative 3), only the minimum reporting, recordkeeping, and monitoring requirements necessary to comply with the Act are specified in the regulations; any additional such requirements as are found to be necessary for a particular OTEC plant design or site will be included as terms and conditions of an individual license.

Any governmental jurisdiction--small or large--whose authority or responsibilities are directly affected by a proposed OTEC facility or plantship will be invited to appoint a representative to participate in the consolidated application review process described in the regulations. The regulations do not impose any reporting, recordkeeping, or other compliance requirements on small governmental jursidictions or small organizations.

The general regulatory approach selected for these regulations was designed to provide the greatest flexibility for, and minimize any adverse economic impact on, any entity--whether large or small--which may become involved in development of commercial OTEC facilities or plantships. Consequently, it is not possible to identify another alternative which would comply with the OTEC Act of 1980 and decrease the already negligible adverse economic impact on small entities.

The consolidated application review procedures contained in the regulations provide a framework for coordinated consideration of federal permits and approvals administered under the regulations issued by various federal agencies. The procedures do not, however, affect the substantive actions to be taken by any agency under its regulations. The Coast Guard's regulations regarding documentation of U.S. vessels do not permit documentation of land-based OTEC plants, which are required by the OTEC Act to be documented in order to be licensed. NOAA's final regulations follow the requirements of the OTEC Act; however, NOAA will continue to work with the Coast Guard to obtain legislative amendments to the OTEC Act to resolve this problem. NOAA is not aware of any other federal rules or regulations which may duplicate, overlap, or conflict with NOAA's regulations to implement the Ocean Thermal Energy Conversion Act of 1980.

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