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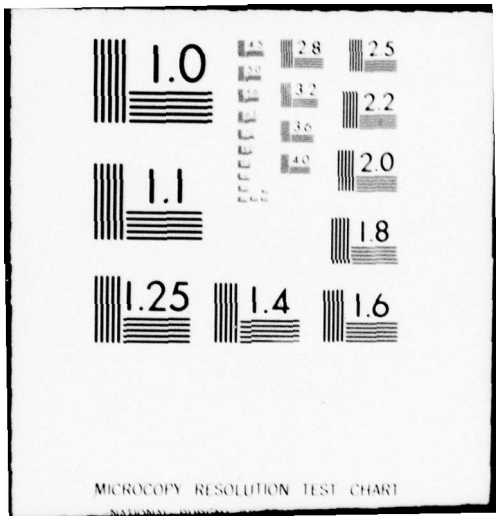
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Report No. CG-D-65-78

FUTURE UNDERWATER ACTIVITIES AND THEIR IMPLICATIONS FOR THE COAST GUARD CIRCA 1978-2000

VOLUME II

CHARLES W. WILLIAMS
RONALD SHALITA
PETER DE ARCANGELIS
KENDALL SIMMIONS
WAYNE R. LOGIE
JOHN PIERRE-BENOIST
EDMUND ANDREWS

AUGUST 1978
FINAL REPORT

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
United States Coast Guard
Office of Research and Development
Washington, D.C. 20590

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16. Abstract

The objectives of this study is to develop forecasts of underwater activities circa 1978-2000 and to assess the implications of these forecasts for the U.S. Coast Guard.

A macro environmental framework, a marine environmental framework, and an underwater activities systems model were structured to form a baseline for a forecast of underwater activities. Data with which to load the models and frameworks was developed through literature reviews, interviews, and written correspondence. The data was organized for each of the underwater activities under the following headings: Operational Systems, Environmental Requirements, Locations, U.S. National Interests, Implications, and Forecasts. Each activity development was then individually analyzed for future evolution, driving forces, barriers, and obviating factors. Each of the fifteen underwater activity categories within the model was translated into "Tailored Vignettes" for the Coast Guard. A final integrative inventory of forecasted operational systems was developed.

Implications of the underwater activities forecasts were provided and analyzed for the current Coast Guard program structure. Conclusions and recommendations were presented as reasonable and important steps to be taken in order to prepare for the anticipated developments and implications.

This is a three volume report. Volume I is the Executive Summary, Volume II is the Final Report and Analysis of Coast Guard Implications, and Volume III is the Detailed Forecasts of Underwater Activity.

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METRIC CONVERSION FACTORS

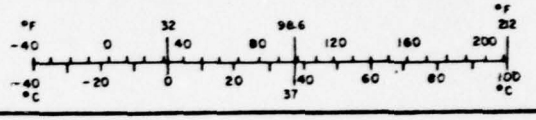
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



METRIC CONVERSION FACTORS

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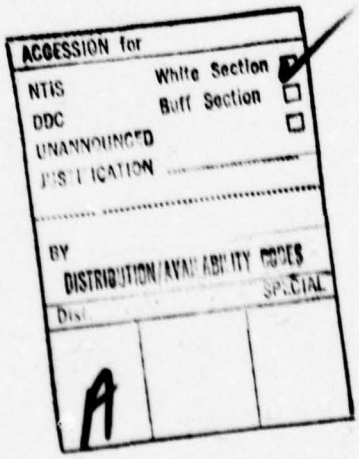


PREFACE

This is Volume Two of a three volume report dealing with forecasted underwater activities circa 1978-2000 and their implications for the U.S. Coast Guard.

The three volumes comprising the total report are:

Volume 1: Executive Summary: a summation of the other two volumes of the report developed with the objective of providing a complete overview of the project.

Volume 2: Basic Report and Analysis of Coast Guard Implications of Future Underwater Activities: a summary of the research process and the analysis of the Coast Guard implications derived from the forecasts presented in detail in Volume 3.

Volume 3: Detailed Forecasts of Underwater Activities: the detailed forecasts for overall underwater activities.

The forecasts are not meant to be exhaustive scenarios containing all aspects of future underwater activities, or all possible "alternative futures." Rather, they are tailored to concentrate upon illuminating those aspects of future underwater activities that will help to define the relationships to Coast Guard missions and operational responsibilities. These are termed "Tailored Vignettes." The concept of "tailored" means that a specialized interpretative dimension to the forecasts is being derived. The concept of "vignette" means that a middle ground is being adopted between comprehensive scenarios of all future possibilities and the event-oriented forecast. The former suffers from a level of generality which makes specific operational implications difficult to define. The latter, the event-oriented forecast, suffers from a specificity which inhibits the needed integrative insights. The "vignette" concept provides a useful "middle ground."

We have presented our conclusions in the form of forecasts and probability estimates within three basic time phases--1981-85, 1986-92, and 1993-2000.

The reader should approach these and all long range forecasts with an acute awareness that:

- The most difficult problem in comprehending probable future developments is overcoming the tendency to perceive the future only as a mirror image of our current operational day-to-day experiences.

- There is no single "right" or "wrong" view, for there cannot be that desired degree of scientific prediction. One is dealing with an art form replete with qualitative as well as quantitative information and judgments, interlaced with societal values, and the complex interactions of scientific, technological, economic, political, and social developments.

- We have sought to provide the reader with sufficient rationale and analysis to understand how we have derived our views, and if he so wishes, to have a baseline from which to develop alternate views if he deems our views to be invalid.

CHAPTER 1: INTRODUCTION/RESEARCH PROCESS

As was discussed in the preface, this report gives the results of a research project to:

- Develop forecasts of underwater activities circa 1978-2000, and
- Assess the implications of these forecasts for the Coast Guard

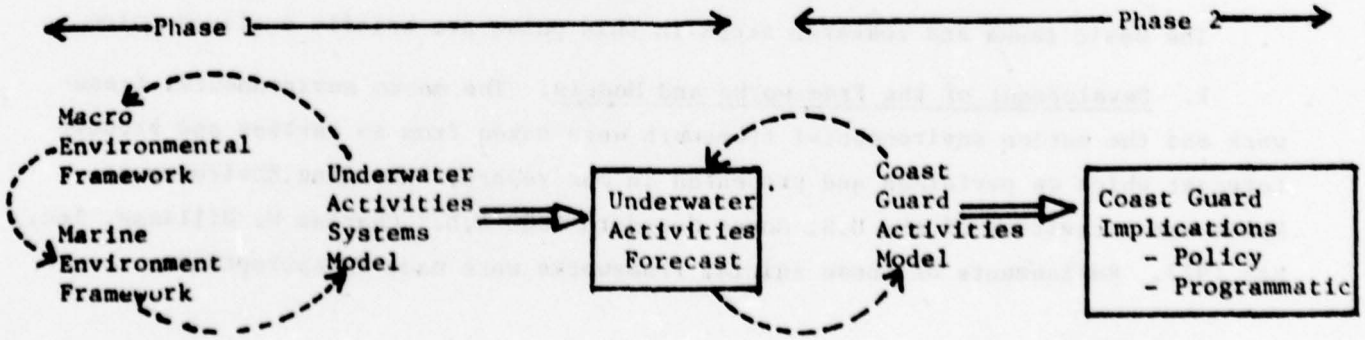
Underwater activities are defined as anything occurring beneath the surface of the water which is related to an active human purpose or interest. The activity may be an extension of operations from the surface downward, from beneath the bottom upward, or fully within the space between the bottom and the surface. By such a broad definition, it becomes difficult to conceptualize what marine activities could be omitted from underwater activities. This problem is dealt with by developing a particular operational definition of underwater activities. Those activities are defined and described in the "Underwater Activities Systems Model" developed specifically for this project.

These underwater activities will become a very important part of our national economy and life, and will have profound impacts upon the Coast Guard. This volume presents a summarization of the forecasted underwater activities (developed in detail in Volume III), and then presents an analysis of their implications to the U.S. Coast Guard.

OVERVIEW OF THE RESEARCH PROCESS

The overall research process is outlined in Figure 1-1. As the figure shows, the research had two phases: development of the underwater activities forecast, and development of the Coast Guard policy and programmatic implications.

FIGURE 1-1: OVERVIEW OF RESEARCH PROCESS



PHASE I: DEVELOPMENT OF UNDERWATER ACTIVITIES FORECAST

The underwater activities forecasts were derived from three basic interactive frameworks/models as is shown by the circular arrows on the left side of Figure 1-1. The basic concept is that underwater activities comprise a "system" which is shaped essentially by: 1) the features of the underwater environment itself; 2) the technological, political, economic, and societal dynamics of the overall macro environment within which institutions operate and which they, in turn, help to shape; and 3) the overall dynamics and development within the marine environment of which the underwater environment is a major component.

Since the objective is to forecast underwater activities, the underwater system is developed in more detail than are the other two frameworks. This distinction of level of detail is denoted by the use of the term "model" rather than "framework." The term "model" is not meant to connote a highly quantified set of different equations, or of input/output coefficients which have been computerized for rapid processing of many variables. Rather, this is a conceptual model. A description of the basic components of the Underwater Activities System together with our analysis of the most significant relationships within the macro and marine environment frameworks, and the analysis and rationale for how these emerge into the forecasts of future underwater developments and activities.

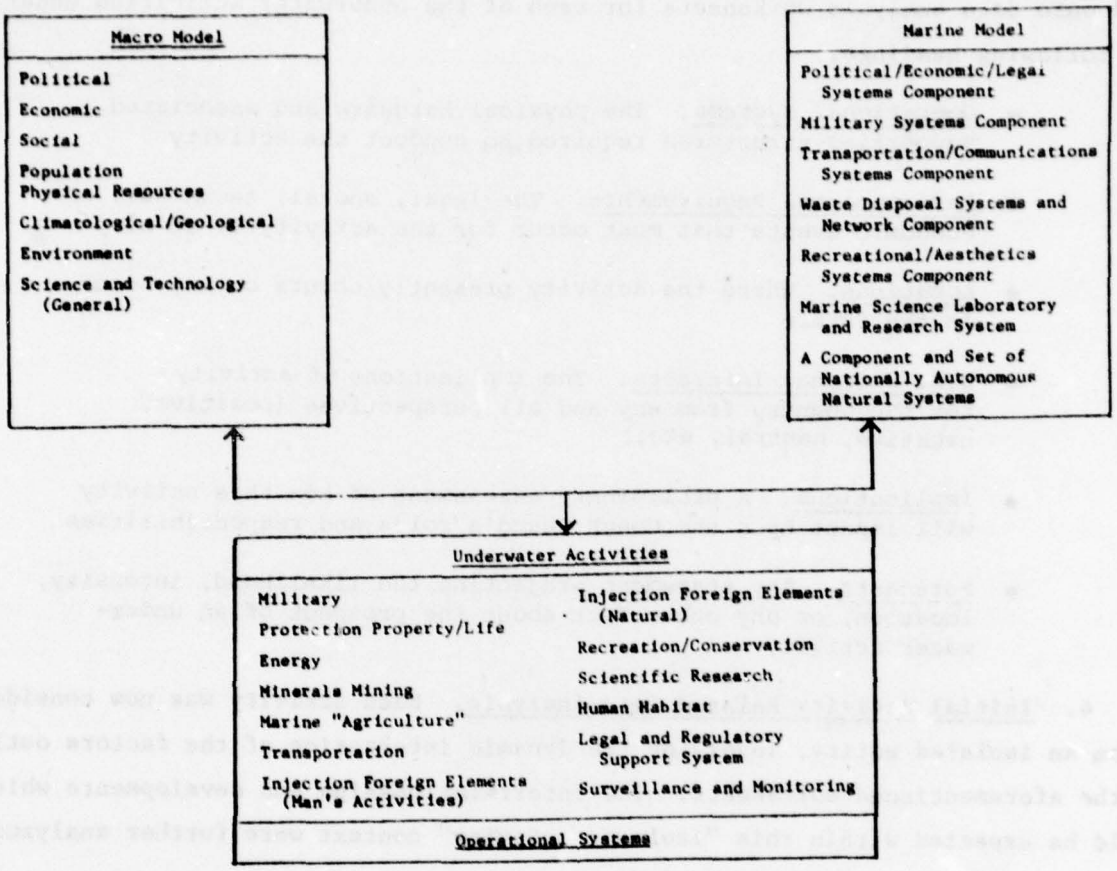
The details of this phase of the research are contained in Volume III. Chapter 2, of this volume, contains an integrative summarization of the results. The structure of the three initial frameworks/models is shown in Figure 1-2.

As the figure suggests, the analytical linkage through which Coast Guard implications are assessed is the Underwater Activities Systems Model. The basic operational systems, which are developed and defined within that model, provide the means of operational linkage, since they outline the types of hardware which we expect the Coast Guard to encounter or to operate.

The basic tasks and research steps in this phase are briefly outlined below.

1. Development of the Frameworks and Models. The macro environmental framework and the marine environmental framework were taken from an earlier and broader forecast which we performed and presented in our report, "Emerging Environments, Roles and Activities of the U.S. Coast Guard to 2000 A.D." Charles W. Williams, Inc., May 1977. Refinements of these initial frameworks were made as appropriate.

FIGURE 1-2: STRUCTURE OF THE THREE INITIAL FRAMEWORKS/MODELS



The underwater activities systems model was structured and developed exclusively for this analysis. It was derived from a combination of data analysis and analysis of the specific activities which would provide the most effective mechanism for linkage into Coast Guard implications. During its construction, the model was refined to provide appropriate classification for comprehensive coverage of all data involved.

2. Data Collection. The data with which to load the models and frameworks was developed through three activities:

- A comprehensive review of the underwater literature, utilizing technical information systems and numerous scientific and non-technical libraries
- A series of interviews with key personnel and experts in a variety of underwater activities in academic, commercial, and industrial institutions
- A series of written correspondence with key experts, who were not contacted personally or by telephone

3. Organization of the Data and "Loading" of the Models and Frameworks. The organizational mechanisms were the structures of the two frameworks and the Underwater Activities System Model. Within these structures, the data was organized onto data analysis worksheets for each of the underwater activities under the following headings:

- Operational Systems. The physical hardware and associated supporting structures required to conduct the activity
- Environmental Requirements. The legal, social, technical, or economic events that must occur for the activity to develop
- Locations. Where the activity presently occurs or may occur in the future
- U.S. National Interests. The implications of activity for the country from any and all perspectives (positive, negative, neutral, etc.)
- Implications. A preliminary assessment of how this activity will impact upon the Coast Guard's roles and responsibilities
- Forecasts. Any statement projecting the likelihood, intensity, location, or any other fact about the prospect of an underwater activity

4. Initial Activity Related Data Analysis. Each activity was now considered to be an isolated entity, involving the dynamic interaction of the factors outlined on the aforementioned worksheets. The interrelationships and developments which would be expected within this "isolated activity" context were further analyzed by integrating the data into the following:

- Basic Steps. The economic, social, or technological alternatives that will be most determinant in how the future evolves
- Driving Forces. The motivating factors which enhance the likelihood of a pattern or concept
- Barriers. Those factors which impede or block the underwater activity from occurring
- Obviating Factors. A factor or event that totally negates the possibility of the underwater activity from developing

5. Integration Into Tailored Forecasts for Each of the Fifteen Underwater Activity Categories Within the Model. This process began with a form of cross-impact analysis which related the basic concepts, driving forces, barriers, and obviating factors for each individual activity within the basic category and

among the basic categories. Initial integrative category frameworks, combining the activity analyses, were developed. These were evaluated further for relationships to macro and marine environmental factors and other underwater activity categories. The process involved the following steps:

- An assessment of the probability that any obviating factor would dominate for a given activity in the light of the integrative relationships
- An analysis of how the basic concepts, driving forces, and key barriers will interact within the underwater activities system model, and between this model and the two broader frameworks
- An articulation of tailored forecasts in the form of a category vignette, together with a brief rationale
- A summarization of the key features of the category vignette with assignment of probability estimates for each of three interim time periods. Four probability estimates are used: high, good, low, minimal. The three interim time periods are: 1981-85, 1986-92, and 1993-2000.

6. Integrative Summary of Major Operational Systems. Since one of the most significant avenues through which the Coast Guard becomes involved with underwater activities is the particular operational systems which are employed, and since a number of activities employ similar types of operational systems, a final integrative inventory of forecasted operational systems was developed.

PHASE II: DEVELOPMENT OF COAST GUARD IMPLICATIONS

The Coast Guard implications will be a function of the dynamics of the following:

- The roles of government vis-a-vis the marine environment
- The roles of private institutions vis-a-vis the marine environment
- The organizational structures of both public and private institutions, but particularly of the federal government with respect to execution of its roles
- The specific roles, missions, responsibilities and requirements assigned to the Coast Guard
- The technologies and resources that are available

FIGURE 1-2: THE UNDERWATER ACTIVITIES SYSTEM MODEL

13 ACTIVITY CATEGORIES	106 ACTIVITIES	OPERATIONAL SYSTEMS
Military	Submarines as Weapons Mines Individuals/Teams Underwater Installations Underwater Logistical Support Surface Weapons Systems Interface Land Based Weapons Systems Interface Surveillance/Monitoring Search and Rescue R&D Marine Mammals Chemical/Biological Warfare	General Systems and Operations 1) Submersibles a. Design Characteristics • Manned and unmanned • Tethered, untethered, towed • Bottom crawlers • Remotely controlled • Lock in/lock out syster • Depth range • Size variation 2) Habitats a. Design Characteristics • Temporary underwater • Temporary sea surface • Permanent underwater • Permanent sea surface • Lock in/lock out syste • Ocean bottom • Size variations 3) Working Platforms/Rigs a. Design Characteristics • Stilt supported • Submerged drilling ba • Jack up barges • Semisubmersibles • Floating platforms • Ocean bottom (Continued)
Protection of Property/Life	"Aggression" from Nonmilitary Forces Against Nonmilitary Targets Natural Disasters Major Accidents Involving Property and Human Life Salvage	
Energy	Offshore Oil and Natural Gas Offshore Coal Production Offshore Uranium Production Floating Solar Heat Collectors Floating Windmills Ocean Thermal Energy Conversion (OTEC) (Continued)	

FIGURE 1-2: THE UNDERWATER ACTIVITIES SYSTEM MODEL (Continued)

13 ACTIVITY CATEGORIES	106 ACTIVITIES	OPERATIONAL SYSTEMS
Energy (Continued)	Tidal Power Ocean Currents Wave Energy Deep Sea Pressure Power Ocean Hydropower Water Salination Power Underwater Geothermal Energy Kelp and Other Aquatic Vegetation Nuclear Power Plants Natural Gas Process Plants Other Power Plants, Refineries, or Conversion Centers *Industrial Process Plants and Other* "Consumers" Located for Direct Consumption of Ocean Generated Energy	4) **Dredges** **a. Design Characteristics** • **Semisubmersible** • **Submersible** • **Ocean bottom** • **Surface** **b. Functional Type** • **Cutter suction** • **Suction hopper** • **Continuous bucket line** • **Vacuum cleaner** 5. **Harvesting Systems** **a. Nets** • **Purse seines** • **Drift nets** • **Bottom dwelling** • **Long lines** • **Trawling** **b. Lines** **c. Hooks** **d. Traps** **e. Electronic stunners** 6. **Surface Vessels** **a. Size variations** **b. Conventional hull design** **c. Platoon structure**
Minerals Mining	Oil and Natural Gas (see Energy) Coal (see Energy) Sulfur Hard Rock Minerals Fresh Water Aquifiers Sand and Gravel Limestone and Shell Placers Manganese Nodules Red Clay/Ooze Chemical Extraction	

(Continued)

(Continue

FIGURE 1-2: THE UNDERWATER ACTIVITIES SYSTEM MODEL (Continued)

13 ACTIVITY CATEGORIES	106 ACTIVITIES	OPERATIONAL SYSTEMS
Minerals Mining (Continued)	Desalination Icebergs	d. Hydrofoil e. Open stern trawlers 7. Divers a. Pressurized suits b. Tank equipped c. Other • Dry suits • Wet suits • Scuba 8. Instrumentation Systems a. Navigational aids • Transponders • Transceivers • Cameras • Strobes • Viewing ports b. Communication and surveillance mechanisms • Visual Direct Photography • Electromagnetic Radar Infrared Laser Other
Marine "Agriculture"	Fish and Shellfish Marine Organisms Marine Plants	
Transportation	Inland Port Operations Coastal Port Operations Offshore Port Operations Underwater Vessels Surface Vessels Diving Without Vessel Cables Pipelines Tunnels, Bridges, Causeways	
Injection Foreign Elements: Man's Activity	DELIBERATE INJECTION Municipal Residuals Industrial Residuals Dredge Residuals Marine Operations Radioactive Materials ACCIDENTAL INJECTION Municipal Industrial Marine Operations Radioactive Materials (Continued)	(Continued)

FIGURE 1-2: THE UNDERWATER ACTIVITIES SYSTEM MODEL (Continued)

13 ACTIVITY CATEGORIES	106 ACTIVITIES	OPERATIONAL SYSTEMS
Injection Foreign Elements: Man's Activity (Continued)	SUBLIMINAL INJECTION Runoff Atmospheric Settling MANAGED INJECTION Nutrients Ecostabilizers and Restorers Naturally "Disposables" Artificial Reefs and Barriers	c. Communication and surveillance components • Hydrophones • Cameras • Underwater transmitter 9. Underwater Hardware a. Manipulators b. Cables • Support • Electric c. Pipelines d. Buoys e. Mines
Injection Foreign Elements: Natural	Atmospheric Settlement Continental Runoff Subterranian Upheaval	
Recreation/Conservation	Unique Points of Interest, e.g., Underwater Caves, Coral Fields, Historic Shipwreck Sites, etc. Critical Habitats for Endangered Living Resources Recreational, Aesthetically Appealing Sites Other Designated Sites	
Scientific Research	Resources Inventory Meteorlogical Relationships Physical Forces (Tides, Currents, etc.) Physical Chemistry Compositions and Dynamics Geological/Geophysical Phenomena and Dynamics Biological/Biochemical Compositions and Dynamics	

(Continued)

FIGURE 1-2: THE UNDERWATER ACTIVITIES SYSTEM MODEL (Continued)

13 BASIC ACTIVITY CATEGORIES	106 ACTIVITIES	OPERATIONAL SYSTEMS
Scientific Research (Continued)	Marine Life Systems of "Higher Organisms" Marine Plant Life Systems Human Organisms in Undersea Environment Engineering Technologies/Systems for Underwater Operations Resource Development and Management International Geopolitical Issues and Resolutions Other Marine Management Issues	
Human Habitat	Temporary "Mobile" or "Transportable" Units Permanent Units Rotational Occupancy Total Living Habitation Direct Worker Quarters Industrial Complex Industrial and/or Commercial Residential Complex Residential Complex	
Legal and Regulatory Activities and Support Systems	Not applicable	
Surveillance and Monitoring	Threat Identification Intelligence Navigation Law Enforcement Search/Rescue/Salvage	

CHAPTER 2: INTEGRATIVE SUMMARY OF FORECASTED UNDERWATER ACTIVITIES

This chapter presents an integrative summary of tailored forecasts of the underwater activities which are contained within Volume 3. The purpose of this summary is to provide a cogent and cohesive structure from which to develop the analysis outlining specific Coast Guard implications. Accordingly, the structure of the forecasts are modified somewhat and are presented not in the context of individual underwater activity categories but rather in the following manner:

- Forecasted macro and marine environmental factors related to future underwater activities
- Forecasted underwater activities
- Forecasted operational systems to be employed in underwater activities

FORECASTED MACRO/MARINE ENVIRONMENTAL FACTORS AND CHARACTERISTICS AFFECTING AND AFFECTED BY FORECASTED UNDERWATER ACTIVITIES

1. National sovereignty will remain as the dominant feature of international governmental structures. Nation states will relinquish such sovereignty only in special circumstances, and then only to the degree to which they perceive such relinquishment to be in their best national interest.

2. The centers of world power will diverge from a bipolar world, largely organized under the USSR Communist bloc and the U.S. free-world bloc, into a multipolar network of nations and blocs. It will be increasingly difficult either to negotiate or to impose world order. While a major nuclear exchange directly between the USSR and the U.S. cannot be ruled out, we forecast its probability to be so low as to not be included within this set of forecasts.

3. As the multipolar world emerges, there will be a general proliferation of world military power. The "nuclear monopoly" will be eroded in two senses: the proliferation of nuclear power itself, and the emergence of a variety of other forms of antisocial technology. The latter can give more nations the equivalent destructive effectiveness of nuclear power. This latter situation might be termed the emergence of nonnuclear strategic parity.

4. There will be accelerated efforts to effect world disarmament. These attempts will achieve limited success in specific types of arms, imposing complex monitoring systems to assure compliance. But there will not be a successful achievement of overall arms limitation and certainly not disarmament. Rather, the overall range of potential weaponry and military capability will increase. The

arms race will enter into its next plateau, and the overall military capability of the world in general, and the U.S. in particular, will continue to build. However, the composition of the weaponry and of the antisocial technologies which undergird such weaponry will undergo significant change.

5. Military capability will continue to hold a major role within international affairs and as instruments of national policy.

6. The U.S. will continue to see itself as needing to fulfull a role as a leading world power. The U.S. also will believe it necessary to retain an effective military capability as a deterrent to aggression.

7. The role and nature of marine military activities will undergo a major change. Transitional naval strategy and tactics will shift from primary reliance upon surface-based military capabilities to primary reliance upon underwater military capabilities. This shift will provide security against those opponents capable of threatening offshore resources and economic operations.

8. The techniques of calculating parity will incorporate new aspects of military operational capabilities. The number of nations involved in the parity/calculations will increase. The U.S. policy will then be to remain effective against any and all potential enemies who may arise out of this increase, and to be able to counter them at any point of the spectrum.

9. Although there will be significant structural changes within it, the overall character of the U.S. economy will continue to be one of technological intensity. It will continue to be an economy in which overall technological leadership is seen as a cornerstone of national development, in both a qualitative and quantitative sense.

10. The problems associated with the increasing resource dependency of the U.S. economy on other nations will become more acute. These problems will lead the U.S. and other nations to retreat, at least in operational behavior, from the current support which tends to reinforce the concept of a "one world economy." This will emerge as it is realized that a one world economy can function as it is theoretically supposed to function only if there is the equivalent means for government, i.e., equivalent to a "one world government." From all of this will come a continuing stream of national priorities for relative national independence in an increasing number of key resources essential to the balanced

and healthy maintenance of U.S. industries and nonspecialized diversified economy. This will lead to changing priorities, policies, incentives and related economic relationships with respect to the development of offshore resources.

11. The economic exploitation of offshore resources as a component of the national and of the international economy will accelerate appreciably.

12. Advances in the state of the art of antisocial technologies will continue across the entire spectrum of possibilities. At the same time, the monopolistic position over the development, production and application of antisocial technologies, which generally has been held by organizations and agencies of national governments, will be eroded. Such capabilities will be operated by smaller organizations at lower costs and with more flexible forms of delivery.

13. There will be a growing propensity to employ antisocial technologies within diverse groups and organizations throughout the world. Protection systems against nonmilitary aggression utilizing antisocial technologies will lag seriously behind the emergence of potential destructive capabilities. A number of dramatic instances involving damages from nonmilitary aggression will occur somewhere in the world, and probabily within U.S. territorial waters or within waters where U.S. interests are involved.

14. There will be a growing and increasing demand for more effective protection systems against antisocial technologies in both the military and nonmilitary realm. These demands will emphasize greater attention to proactive protection. But there also will be a strong expectation that the reactive capabilities of protection agencies and institutions will be sufficient.

15. The problem of determining, in the marine environment, whether a threat is present and whether the threat has resulted from a foreign military or nonmilitary source will become an increasing intractable problem. In a growing number of areas there ultimately will be a merger of operational responsibilities for some areas of protection and surveilliance which characteristically have been more clearly defined as either military or nonmilitary.

16. Although many improvements in protection from nonmilitary applications of antisocial technologies will evolve, the protection/threat gap will not be fully closed. This will drive officials to seek improved forms of intelligence by which to know whether antisocial technological applications are being readied and by whom. This intelligence network will be similar to the type of knowledge obtained in military operations and to criminal operation on the mainland.

17. Capabilities to predict the occurrence of natural disasters will grow significantly, creating a demand for more effective advance measures to reduce loss of property and life.

18. The range of and potential likelihood of accidents will grow in all categories as a direct result of increased activities. There will be major drives to instill additional regulatory controls to assure accident-prevention programs are designed and executed effectively. These will include employment of sea zoning concepts, navigation and equipment advances, and personnel qualification standards. The probability of transportation accidents will be increased by the changing nature of some vessels. For example, the equivalent of the super tanker likely will be developed for at least some other major raw materials, leading to super ore carriers and to super cargo carriers.

19. Search and rescue requirements will intensify.

20. Salvage operations will become more important, and will require new forms of mechanisms and responsibilities for location and protection from theft of damaged structures under the surface.

21. The economy will remain energy intense. The overall demand for energy will continue to escalate at a rate within one to three percentage points of that established over the last several years.

22. The search for alternative energy sources and systems will intensify as the need for greater national energy independence increases, along with the realization that such independence is not achievable through contemporary fossil-based energy sources.

23. Systematic discovery and inventory of the earth's total nonrenewable resources and renewable resource production potential will evolve at a rapid pace. Toward the end of the century there will be greatly increased capability to model the location and amount of reserves, the rates of their depletion, and the ecological consequences of various ways to extract and use them.

24. Suitable substitutes for the various mineral and energy resources located in the marine environment will emerge. However, these substitutes will not be sufficient to depress the basic demand for development of the offshore resources needed to supplement the U.S. economy, the international economy and the land based resources. Consequently, development and reliance upon offshore resources within the territorial control of the U.S. will grow rapidly.

25. Offshore electrical generating plants will become a major area of interest. They will include facilities for nuclear power generation, and possibly fuel burning generation (especially for offshore coal), ocean thermal gradient generation, tidal and wave power conversion, and perhaps even electrical generation by ocean currents.

26. The universal ownership of the oceans' resources, with effective world organizations to manage the development of the resources and the distribution of values derived therefrom, will not become a reality during this century. Development will continue along national lines. There will, however, be a growing number of bilateral and multilateral treaties and international agreements, which will tend to affect and "govern" overall behavior of nations within the marine environment. The monitorship of compliance by U.S. and other parties will become more complicated and more important in overall management of national and international policy.

27. The territorial limits of interest to the U.S. and other nations will continue to expand in terms of sea boundaries. The current 200-mile limit will not remain stable. It will be pushed outward in varying scope and configuration as the economic potential and military significance of the underwater environment continue to grow. These trends will create a variety of conflicts as to rights of access, particularly in those areas involving straits or other channels of relatively narrow passages.

28. Environmental concerns and issues will grow, but they will not stop the emergence of offshore resource development. They will, however, substantially affect how such development occurs and how it will be monitored.

29. Problems of multiple use of offshore areas will intensify dramatically. These will lead ultimately to some form of national policy and guidelines regarding sea zones and permissible uses therein. Political, administrative and judicial procedures will be developed to provide for the processes needed to resolve the conflicts. In some instances offshore resources will be restricted from development, at least until there are no alternatives left elsewhere, an eventuality which is beyond the time period of this forecast.

30. Aesthetic preservation will continue to be a major political and economic issue with respect to the tapping of offshore resources. Recreational demands and concepts of underwater conservation areas will develop and gain political power.

31. Offshore agricultural activities will shift from a hunt and catch strategy to a manage and cultivate strategy.

32. The relative importance of marine transportation will increase. U.S. port capability will become an important factor in national policy in terms of absolute capacity. Regional location will be a determinant equally important as the opportunity for regional development, especially with respect to inland ports, and with respect to the handling systems and intermodal fluidity which can be accommodated. There will be major drives for increased productivity of the marine transportation networks. This will lead to further advancement of the concepts of modular ships, super ore vessels, and super cargo vessels. Offshore port facilities, including ore slurry pipelines, will become a more important factor in the overall development of the productivity and efficiency of the transportation system. Modular containerization and automatic handling mechanisms will become mainstays of the day-to-day operations. Few vessels or ports which have not been converted or adapted in some manner to these new technological capabilities will remain at the turn of the century.

33. The marine environment will come to be seen as a component of an overall waste disposal/management system. In this sense, antipollutants and pollution control procedures will continue in importance and grow in absolute terms. However, they will decrease proportionally in favor of concepts which

consider the offshore environment to represent a natural disposal system. Parallel with, and complementary to, this concept will be the emergence of positive management. Some wastes may be regarded as nutrients which increase the productivity of the marine environment, especially the agricultural productivity.

34. Overall economic development will continue to sustain increased interest in recreational activities. The marine environment will continue to be a popular area for such activities.

35. Scientific interest and exploration of the marine environment will expand rapidly. Instrumentation, techniques, and all areas of ocean or marine science will be moving in very dynamic ways. These developments will span the entire range of activities which will be associated with the development of the offshore resources and activities.

36. In general, no single factor will act to generate a "crisis rush" to move within the marine environment. That is to say, the world food problem will not become so acute as to require that massive amounts of the world's protein requirements must be drawn from the sea because there exists no alternative sustenance for life. Population growth will not create such numbers of people that they must live in cities moored offshore, or in underwater communities because there is insufficient space anywhere else. Energy resources will not be so depleted as to create a frantic rush to exploit all forms of offshore energy potential so as to rescue the nation or the world from a crisis. While there will, of course, be differing rates of development, and differing levels of need within the overall marine structure, it will be more of an evolutionary rather than a revolutionary transition. However we emphasize that even this evolutionary pattern will, by the turn of the century, be perceived to represent what may be characterized as a "revolution" of activities within the marine environment in international and national affairs.

SUMMARY OF FORECASTS RELATED TO EACH INDIVIDUAL UNDERWATER ACTIVITY

The Underwater Activities Systems Model contains 143 discrete underwater activities. This section outlines each activity as it is expected to unfold.

Military

Submarines as Weapons. The importance of submarines as weapons will increase significantly. There will be more diverse types of submarines, generally smaller and more maneuverable than the present average size and generally capable of total operations against other submarines, surface vessels, and land-based targets. The submarines will be important components of offensive strategic forces, of offensive tactical forces and of defensive, strategic and tactical forces.

While the more sophisticated submarines discussed above will have a limited operation and only by advanced military powers, many nations will have acquired the capability to operate divers and teams in association with small submersibles in the relatively shallow waters over the OCS, and in the regions in which entrepreneurship has established resource-exploiting assets.

Mines. Since technology will still not permit total discrimination and selective control of mine detonations, advanced military nations will use mines primarily in waters prohibited to their own forces. Mines will be important components of defensive or access-denial strategies.

For lesser developed nations without the capability to develop subsurface resources of their own, mines will offer attractive capabilities to prevent development by others, or to destroy subsurface assets already in place. In this sense, mines may become a significant "offensive threat."

Individuals/Teams. Individual divers and teams of divers will be used increasingly in a myriad of situations. Divers will have expanded capability for initiating distructive acts.

Underwater Military Installations. Underwater installations will begin to appear for various logistical and support operations. Some of them may be fixed, but most will be semifixed, analogous to the siting of a house trailer.

By the late 1990's, improvements in underwater surveillance and command and control capability, based upon operating units in underwater installations, will be possible.

Underwater Logistic Support. By the end of the century, there will be clear evidence of the emergence of mass transportation of troops and supplies as a vital factor in underwater activities. Underwater transportation of large volumes will be more secure than surface transportation under hostile conditions and more economical than air transport. Thus, large transport submarines will begin to be operational by the end of the century.

In addition, there will begin to appear submerged submarine tenders and supply ships capable of submerged docking and other interactions with underwater installations and craft.

Surface and Land Based Weapons Systems Interface. Coordination relationships between subsurface weapon systems, land based command and control stations, and land based weapons systems will grow. Land based missils will be capable of being guided into the water to seek subsurface targets. Ultimately, missiles will be launched from land, enter the water at some prearranged distance from the target, then exit the water for final attack on targets. The sea opacity will be used to screen the missile during its last leg of transit toward its target.

Air Based Weapons Systems Interface. In general, the same principals apply here as in the above topic. Command and control technology advances will lead to improved coordination between air and subsurface operating units, and between air launched missiles. Ultimately missiles may be launched from beneath the surface with the objective of targeting upon an airborne object.

Surveillance and Monitoring. The impenetrability of sea water to electromagnetic, magnetic, and acoustic surveillance mechanisms will persist beyond the turn of the century. Technology advances will center around sonic techniques.

One of the most acute surveillance problems will be to determine that an aggressive action has, in fact, taken place. Successful covert action will be masked in such a way as to make it very difficult to ascertain causes of damage or interference in operations.

Surveillance countermeasures will continue to be creatively developed and deployed.

It will become possible to have real-time display of entire regions showing virtually all activities taking place in the region. These displays will be placed in a variety of locations for operations by all levels of command.

Military R&D. All areas of R&D related to the categories discussed above will be intensively pursued. Military R&D will be coordinated with increased nonmilitary R&D on the underwater environment.

Marine Mammals. More species and greater quantities of marine mammals will be used for spotting subsurface structures and protecting divers.

Mammals will be equipped with internal explosive devices which can be triggered from a remotely controlled operations center. Such "delivery systems" will be virtually indistinguishable from natural movement. These will present major defense, surveillance and tracking problems.

The equivalent of "marine mammal guard dogs" under the sea is likely to evolve in some areas with many activities. Armed with sensors, these mammals will make excellent observation units at a much more reasonable cost than would be the case with underwater vehicles.

Protection of Property and Life (Nonmilitary)

Nonmilitary Applications of Antisocial Technology. This will become a major area of protection concern. There will be high priority assigned to the development of surveillance, tracking, interception and reaction capability. Ultimately, efforts will be extended to include "intelligence types" activities, which will help to make possible the determination that a threat is about to occur and/or the affixing of the responsibility for an action.

Many of the future antisocial technologies will be deliverable in forms which are hardly discernible (see "Military" above). The result may be masked as a "natural" event. Even when the origin of these events is delineated, determination of responsibility will be more difficult. This will become a major area of concern vis-a-vis underwater protection activities.

Natural Disasters. Some progress will be made in the control of natural disasters (such as in the dispersing of hurricanes) but in general the preventive controls will remain highly limited.

Their predictability will grow substantially; however, the capacity to forecast the events and calculate more precisely their potential patterns will accelerate the pressures for evacuation and for preventive measures which can minimize damage.

Major Accidents Involving Threats or Damage to Property and Life. There will be major increases in the number of accidents likely to occur, the magnitude of accidents, and the danger which the accidents can impose on life and property.

There will be increased pressures for preventive accident control measures along with ready response capability to deal with any form of accident which does occur.

Problems of potentially dangerous cargoes will continue to escalate and will become a major area of specialization within the overall protection activities.

Search and Rescue Operations. Demands for search and rescue operations will grow. The response times and overall surveillance systems will revolutionize the approach to search operations. Technology will improve the search function. Rescue requirements will extend to the evacuation of more personnel. Underwater rescue capabilities related to operational units beneath the surface will grow substantially.

Salvage Operations. Salvage will become a much more important component of the overall underwater activities. It will be necessary to have the capability to readily locate damaged assets, to guard them and to effectively salvage what can be salvaged from them.

Energy

Oil and Natural Gas. Development of offshore oil and natural gas will experience a continuing growth. By the turn of the century many, if not most, of the reserves beneath the oceans and on land will be inventoried and located. Operations will be conducted in many locations, from submerged and bottom-based rigs as well as from surface rigs. In fact, this will be the leading area for development of marine based mineral mining within this forecast period.

Offshore Coal Mining. Some offshore coal reserves will be tapped, initially through extension from land based shafts, and later from adaptation of oil and gas extraction technology. Ultimately, coal will be pumped as slurry through pipelines for direct transport to shore-based facilities.

A coal burning electrical generation plant located offshore is also a likely development.

Offshore Production of Uranium. Offshore production of uranium will become increasingly attractive as the prominence of nuclear energy takes shape during the 1980's. Some offshore uranium mining activities will be undertaken. It is likely that these uranium mining efforts will be limited to extraction from that which is suspended within sea water, rather than by actual uranium mineshafts sunk through the ocean bottom.

Kelp Biomass. The reliance upon the marine environment for kelp as a source of fuel will be limited. On the West Coast there will be a few experiments to cultivate, harvest, and process kelp.

Ocean Thermal Energy Conversion. Feasibility of concept will be proven viable for electric generation. Commercial acceptance and application of the process will take place before or during the early 1990s.

Tidal Power Conversion. Tidal power conversion is highly limited within U.S. waters by geophysical requirements. There will be in operation, or under construction, at least one and perhaps two tidal power generation stations.

Wave Power Conversion. Wave power will not be used on a large scale for electrical energy generation for shore-based needs. Wave power will become a major source of in-place power for operation of buoy systems and other forms of instrumentation having low power requirements. Buoy systems also may find limited application for small vessels.

Offshore Collection of Solar Heat. Solar heat collection offshore will find application in offshore operations connected with other purposes. It will not likely be used for large scale energy generation for shore based needs. Such application will be limited to relatively small scale experimental or pilot projects.

Offshore Wind Energy Conversion. Some experimental sites will be constructed for wind energy conversion, and possibly some offshore facilities will be equipped with wind energy capabilities. In general there will not be extensive exploitation of the offshore wind energy potential within this century.

Offshore Nuclear Power Plants. A number of offshore nuclear power plants will be under construction and some will be in operation before 1990.

Industrial Plants for Direct Energy Use. There will be a few highly selective industrial production plants located offshore, using directly energy sources from beneath the seabed.

Mineral Mining Other Than Fossil Fuels

Sulfur

There will begin to be greater exploitation of offshore sulfur deposits during the last years of the century.

Hard Rock Mining. The technological innovations associated with offshore coal production will provide a technological base, which will be adapted to other forms of offshore hard rock mining. A few offshore ocean bottom mines (strip or shaft) will be in operation for highly critical minerals.

Sand and Gravel. Sand and gravel will be extensively mined from offshore facilities. Transportation to shore-based users will occur through both vessels and pipelines.

Limestone and Shell. A rapid and extensive development of offshore limestone and shell will occur.

Placers. There will be increasing interest in offshore development of minerals classified in this category. Some selected placer mining operations will be in effect.

Manganese Nodules. There will be a rather rapid acceleration in worldwide extraction of nodules, including applications within the territorial waters of the U.S.

Red Clay/Ooze. No significant activity for mining of red clay/ooze.

Phosphorite. Though it will be slow in developing, some mining of offshore phosphorite will be occurring before the turn of the century.

Metaliferous Muds. At least a few areas of mining in this category will emerge. It will not be an extensive activity.

Chemical Extraction. Although the removal of such minerals as salt, bromine, and magnesium will continue to grow slightly, there will be little impact upon overall underwater activities beyond the types of impacts now experienced.

Desalination. Desalination technology will be developed probably outside the U.S. It will be applied within at least a number of localized U.S. sites along the east and/or west coasts of the mainland, and possibly around Hawaii.

Iceberg Towing. Though they will be highly limited, some experimental iceberg towing projects will be undertaken somewhere in the world. At least one such experiment is likely to be located within U. S. waters or be conducted or funded by a U.S. based enterprise.

Offshore Agricultural Production

Commercial and Recreational Fishing. Fish management techniques will continue to improve. This will include monitoring the inventory of various fish populations, developing aquacultural and ocean farming techniques, and developing other means for increasing the yield and productivity of the fishing commodities.

Extensive research will be conducted to find new product development applications for underutilized fish species and for other forms of marine life.

The U.S. fishing fleet will become technologically updated, and fish exports via foreign vessels harvesting in U.S. waters will grow into an important source of foreign exchange. Offshore fish processing is likely to develop, at least to some degree.

Recreational fishing will grow in importance. Conflicts will arise between fishing and other commercial and recreational uses of the waters. Zoning will occur as a means of resolving these conflicts.

Cultivation and management of fish productivity will become intertwined with waste disposal and injection management. Some wastes which can serve as nutrients to increase fish productivity will be selectively sought as positive management of injection/waste.

Growth and Harvesting of Other Marine Organisms. General underwater agricultural growth will expand to include other organisms. Scientific teams will systematically search for new means of developing the offshore marine resources. However, the major evolutions and developments are still expected to occur in fishing.

Growth and Harvesting of Marine Plants. The ways in which to use marine plants will become more varied. Use of kelp as biomass was discussed earlier. Other applications include algae as a nutrient source, and various forms of plants for pharmaceutical and chemical applications. In general, this will be a rather sluggish but still expanding domain of underwater agricultural activities.

Transportation Activities

Inland Ports. Inland ports will become more important elements of regional economic development opportunity. They will be expanded and new ones will be built. They also will be linked with large scale cargo carriers via offshore ports, which will be used to offload cargo onto barges for distribution to both coastal and inland ports.

Volumes of goods flowing through inland ports will increase because water transport of domestically produced good to other domestic destinations will become more attractive and economically competitive as transportation costs of land based systems escalate.

Coastal Ports. There will be major renovations of coastal ports in terms of warehouses and equipment for handling materials. In addition, more coastal port facilities will be developed, including some new coastal ports.

Offshore Ports. Offshore ports will emerge off the Louisiana and Texas coasts. At first they will be single mooring points for handling petroleum. Later, liquid natural gas and other dangerous liquids will be handled. Still later, slurry pipelines for carrying ores and crushed raw materials will come into use. Finally, platforms and other concepts for transfer to and from cargo ships and other vessels that cannot get ready access to coastal or inland ports will be added.

Underwater Vessels. Military submersibles will increase significantly as has already been discussed in Chapter 2 of Volume III. The problem of discrimination and detection of submersible activity will create significant problems in military security.

Submersibles in operation will be for military or commercial purposes. Recreational submersibles will be in use, but not in significant numbers.

Commercially operated recreational submersibles offering group tours will come into use. There will be at least several such "pleasure craft" in operation by the 1990s.

The number of divers, however, will increase significantly. Diving activities in terms of individual divers will increase in both commercial and recreational areas. Even recreational divers will be operating in depths of up to 300 feet.

Underwater Pipelines. Underwater pipelines will be used extensively. They will connect underwater mining operations to shore based facilities as well as offshore ports.

Underwater Cables. Underwater cables for purposes of communications will become obsolete, replaced by satellite technologies. Only those currently in operation are likely to remain. They will continue operation until their economic usefulness is no longer competitive.

Underwater cables for the transport of electrical energy will be commonly used, and they will become an important component of the overall underwater transportation systems.

Tunnels, Bridges, and Causeways. Although there may be some incremental additions, the total number of new tunnels and bridges is not expected to be significant.

Some causeways likely will be built as a by-product of breakers used to stabilize offshore electrical plants or other production operations.

Injection of Foreign Elements from Man's Activities

Deliberate Injection From Municipal Residuals. Offshore deposition of municipal residuals will continue to occur. However, the overall emphasis will have shifted to a positive form of management. Most of the residuals which create pollution problems will have either been eliminated, handled in other ways, or pretreated to neutralize the degrading impacts.

Sludge, in particular, will become a nutrient. It will receive various forms of treatment which will permit it to be dumped or pumped into fishing grounds. There, it will fertilize plant growth and, in turn, increase the productivity of the fish population.

Other municipal wastes will be classified as acceptable for injection into the marine environment because the marine environment can absorb and process the waste as a natural waste disposal system. The levels of injection will be carefully monitored so as not to overload the tolerances.

Pollution controls still will be an important dimension of the management of injections, but they will be of relatively less significance.

The modes of delivery of municipal residuals will include barging and other vessels, pipelines, and direct dumping from platforms. Each method and the area into which the injection occurs will be managed separately.

Deliberate Injections From Industrial Residuals. The principals and situations here will parallel those of the municipal residuals. Common facilities for injecting the industrial counterparts will be shared in some instances. Separately operated injection systems will be employed for some industries and for some specialized operations.

Deliberate Injection of Dredge Residuals. Dredge residuals will become an increasing aspect of underwater management. Dredging requirements will expand and landfills inland will decrease. Pipelines and vessels carrying dredge residuals into acceptable zones for injection will be used.

Dredging operations in connection with underwater activities offshore will be in much greater abundance. Various forms of new dredge systems will be employed to control the environmental aspects of these dredging operations.

However, the primary means of dealing with the dredge residuals will either be to use them for "ocean fills" to build artificial barriers needed for marine activities or to pump/carry them far out to sea. The sea with its great depths will disperse and absorb the deposits without deleterious consequences to the ocean environment.

Deliberate Injections From Marine Operations. Dredging, which is one of the more important sources of deliberate injection from marine operations, has been discussed in the preceding activity. Other injections will relate to the waste disposal of residuals generated in underwater systems and in the various offshore facilities. Vessels will continue to expel waste. Some on-board treatment techniques can be expected which will make it possible to neutralize some such wastes. Acceptable residuals, which will be permissible for deliberate injection, will follow the same principals as other deliberate injections.

Deliberate Injections of Radioactive Residuals. The problems associated with securing the containers of radioactive wastes will not be fully resolved by the turn of the century. In fact, some episodes of leakage can be expected to occur and receive highly visible and dramatic publicity.

The prohibition of deposit of radioactive waste is the most likely position.

Accidental Injection of Municipal Residuals. Due to their manageability, there will be few instances of accidental injections of municipal residuals into the ocean. They will be of such a relatively minor level as to pose no significant implications.

Accidental Injection of Industrial Residuals. Essentially, the same principals as defined in the preceding item, above, will also apply here.

The key exception will be those industrial activities located offshore. They are included below in marine operations.

Accidental Injection From Marine Operations. Accidental injection from marine operations will pose major and increasing problems to management of this area. Vessels, pipelines, and other forms of transportation will be an expanding problem. The volumes and the rates of flow involved will make the event of accidental spillage a greater impact.

The diversity of cargoes and the increasing amount of traffic involving dangerous cargoes via marine transportation systems will grow and present a major problem.

Accident injections from offshore facilities, including the limited number of offshore power and industrial plants, will become a greater matter for concern. Equipment specifications will be an important component of preventive management.

Accidental Injection of Radioactive Materials. This will be a relatively low level risk, but a high level impact when it does occur. Offshore nuclear plants and nuclear powered vessels will pose some problem, and occasional leakages or spillages will occur which will require immediate emergency action.

Subliminal Injection From "Runoff." Injection from runoff will continue to be a problem. It will be managed by increased control of residuals at the source, thus reducing the runoff problems. However, this will continue to be a major problem.

As the consequences of such runoffs are more clearly defined, and new consequences discovered, and as the agricultural activities increase offshore, the costs of such injections, which degrade offshore productivity, will become a relatively greater concern than the purely environmenatl degradation issues.

Subliminal Injection From Atmospheric Settling. The measurement and definition of such injections will become much more refined. Sources of the residuals settling from the atmosphere will become more determinable. Preventive controls at the source will become more effective; but there will still be major injections from atmospheric settling.

The underwater activities of concern here will consist of measurement. If the injections result in dangerous levels of pollution or contamination which threaten the productivity or some other high priority objective, then

neutralization will be attempted. Otherwise, the injection simply will be accepted.

Managed Injection of Nutrients. The concepts of increased productivity of the offshore agricultural production will lead to definition of the concepts of positive control and injection of nutrients as productivity agents. In this sense, residuals which can fulfill that purpose will be welcomed into appropriate predesignated areas. The primary management concerns will involve designation of areas and monitoring of the injections.

Managed Injection of Ecostabilizers and Restorers. The occurance of injections will lead to the development of various chemical agents and formulations, which will act to neutralize undesirable ecological consequences. This will be a rapidly developing area and one of complex specialized application.

Managed Injection of Natural "Disposables." This has been discussed above. The management problems will center around determination of what is naturally acceptable and processable, including quantities and locations. This, in turn, will be followed with sound monitoring to assure that the criteria are sustained.

Managed Injection of Artificial Reefs and Barriers. There will be a limited number of artificial barriers constructed. This will not be a major activity, but it will be important in the locales where such construction is in process.

Injection of Foreign Elements From Natural Sources

Atmospheric Settlement. Atmospheric settlement will involve various residuals, which are injected into the underwater environment from natural sources. These will remain essentially noncontrollable and will be monitored but little direct action such as emission regulations will be imposed.

Some exceptions to this rule may apply. For example, if a volcanic eruption results in major siltation problems from settling ash in or around the locations of offshore facilities or agricultural production areas, then some form of neutralization will be required. These neutralization techniques will be relatively unused, but will be a needed capability and will be operated on a high priority basis when required.

Continental Runoff. Continental runoff of residuals, generated from onshore natural elements, will not be a significant form of injection.

Subterranean Upheaval. Various upheavals such as volcanic eruptions, earthquakes, and rising islands will continue to occur. It is possible that there will be an increase in such phenomena. They will be regarded as uncontrollable acts of God. Actions which preclude these events will not emerge, but precautions to protect life and property will be taken.

Such events primarily will be monitored for purposes of scientific interests, and not for operational responsibility of management of the marine environment.

Biological Growth. Inordinate or undesired biological growth occurring naturally will become a matter of more concern as the underwater activities emerge. For example, if such growth occurred in recreational parks and inhibited the intended use of the underwater park, action would be taken to eliminate the growth.

This will be an area of highly selected concern, and will become a factor to be dealt with if productivity or useful operations are disturbed. Otherwise, the matter will be monitored but operationally ignored.

Recreation/Conservation Preserves.

Protection of Endangered Species. More species will become endangered. Enforcement of protection will be demanded and stringently applied. There will be some conflicts but endangered species will usually be afforded protection. Protection of these species will be provided for by international agreements.

Protection of Critical Habitats, Estuaries, Coral Reefs, etc. Certain marine life habitats, such as breeding grounds, estuaries, and coral reefs which command special interest, will be afforded specialized protection. Recreational activities will be permitted so long as they are of a nondestructive type.

Recreational Underwater Parks. There will be rapid growth in designation of underwater parks for both conservation and recreational purposes.

Protection of Unique Points of Interest. Certain historic sites, or those having unique social significance, will be set aside as a specific type of preserve. Sunken ships, special geological interest points, and points of unique natural beauty will be afforded protection as specialized parks.

Set Asides For Other Specialized Reasons Including "Marine Wilderness" Areas for Retention in Natural States. Some areas will be marked for retention in their natural states. Access will be highly limited to such purposes as scientific research and highly restricted educational uses. General public/recreational

activities which could in any way disturb the natural systems will not be permitted.

(Note: Other types of recreation, such as diving, fishing, and boating, are covered under the relevant functional activity such as "Transportation" and "Marine Agriculture.")

Scientific Research

Scientific research will continue to expand, grow, and diversify within the underwater environment; the basic scientific activities are classified as follows:

Inventory of the earth's resources and ecological systems
Meteorological relationships
Physical forces (tides, currents, etc.)
Physical chemistry compositions and dynamics
Geological/geophysical phenomena and dynamics
Marine life systems and higher organisms
Marine plant systems
Human organisms in undersea environments
Engineering technologies/systems for underwater operations
Resource development and management
International geopolitical issues and resolutions
Other marine management issues
Other scientific and research activities

Underwater Marine Habitation

Commercial. Temporary underwater commercial habitats will be highly mobile, will house a small number of workers, and will be located in areas of very intense activity, such as mineral extraction sites. Such facilities will be movable to other locales.

Scientific. Although similar to the commercial habitat, the scientific habitat will be equipped with a more complex and sophisticated instrumentation system to conduct marine research. The complex will be able to descend to greater depths than its commercial counterpart.

Military. These habitats will house a host of surveillance and monitoring devices, perhaps will employ a network of defensive and offensive weaponry systems, and will be highly mobile for relocation purposes.

Recreational. These underwater structures will include floating hotels with some rooms underwater, and subsea restaurants which are located in relatively shallow depths of 50 feet or less.

Permanent Living Quarters/Residential Complexes. It is unlikely that any underwater permanent habitation will be constructed or even experimentally demonstrated.

Legal and Regulatory Activities and Support Systems

Inspection and regulatory responsibilities will expand at a rapid and intense rate, requiring demands on new equipment and adaptation of leading technologies. Compliance with standards for all activities in the underwater will lead to new systems of licensing, equipment standards, and behavioral standards. Inspection techniques will rely increasingly upon the utilization of submersibles and underwater detection and observation equipemnt.

Surveillance and Monitoring

The rapid expansion of underwater activities, the increasing use of military systems in the underwater and the threat imposed by antisocial technologies will all help to promote the development of an underwater surveillance and monitoring system. This system will be characterized by subsurface listening posts, satellites, and vessels equipped with sensing devices, all of which integrate into a vast network of tracking and detection capabilities.

CHAPTER 3: IMPLICATIONS FOR COAST GUARD

INTRODUCTION

The foregoing underwater activities entail extensive and significant implications for virtually all areas of Coast Guard activities. This chapter outlines these implications. This introductory section outlines the basic forecasts about the role and nature of the Coast Guard and of the overall organizational environment within which it will function. Then a series of general implications for overall Coast Guard roles, missions and responsibilities will be outlined in terms of national needs and requirements which are forecast to be assigned to the Coast Guard.

THE BASIC ROLES AND ORGANIZATIONAL STRUCTURE WITHIN WHICH THE CG WILL OPERATE

The functions of the Executive Branch of the federal government relevant to the marine environment can be grouped into nonexclusive roles as follows:

Regulation: including certification and licensing

Law enforcement: including surveillance, investigations, apprehension, hearings, imposition of penalties

Research: particularly into methods of conserving or exploiting resources

Services: directly to the public or to industry

Development: of resources and capabilities, e.g., development of fisheries, sea water or seabed energy resources, seabed mining technology, etc.

Operations: of ships, aircraft, other vehicles, stations, etc.

Defense: i.e., military

Foreign relations: including such activities as international negotiations over fishing rights, seabed resources, etc.

Figure 3-1 summarizes the matrix of federal agencies directly involved in these roles as they relate to the marine environment.

FIGURE 3-1: SUMMARY OF FEDERAL AGENCIES DIRECTLY INVOLVED IN MARINE DEVELOPMENT[1/]

Agency		Functions							
		Regulation	Enforcement	Research	Services	Development	Operations	Defense/Military	Fisheries	Judicial Processes
COMMERCE:	National Oceanic/Atmospheric Adm.			X	X	X				
	Maritime Administration				X	X	X			
INTERIOR:	Bureau of Land Management	X		X	X	X	X			
	Office of Water Research & Technology									
	Geological Survey	X				X				
	Mining Enforcement & Safety Adm.		X							
	Bureau of Mines			X						
	Ocean Mining Adm.					X				
	Bureau of Outdoor Recreation			X	X	X			X	
	Fish & Wildlife Service			X		X				
TRANSP.:	Coast Guard	X	X	X	X		X	X	X	X
	St. Lawrence Seaway Corp.				X		X		X	
	Materials Transportation Bureau	X	X							
ENERGY:	Solar Energy Division			X		X				
ENVIRONMENTAL PROTECTION AGENCY		X	X							
LABOR:	Occupational Safety & Health Adm.	X	X							
DEFENSE:	Navy (including Navy Oceanographic)			X				X		
	Corps. of Engineers	X				X	X			
TREASURY:	Bureau of Alcohol/Tobacco/Firearms	X	X							
	Customs Service	X	X							
JUSTICE:	Drug Enforcement Administration	X	X	X						
	Immigration/Naturalization Services		X							
	Occupational Safety/Health Commission		X							
	National Transportation Safety Board		X							

The most basic question to be resolved within the forecast of specific implications for the Coast Guard is whether there will be a Coast Guard, and, if so, what roles, missions, and responsibilities will be assigned to it.

It is clear from Chapter 2 that the dynamic nature of future developments likely will stimulate significant organizational changes within government. We have forecasted in earlier reports that during the 1980's there will emerge some form of cabinet level executive department for marine affairs. We do not, however, believe that all functions and responsibilities associated with the marine environment will be groupable. For example, the military functions will primarily remain

1/ "Emerging Environments, Roles and Activities of the U.S. Coast Guard to 2000 A.D.," Charles W. Williams, Inc., May 1977.

a coordinative responsibility of the Department of Defense, so that these capabilities can be interfaced effectively with the other armed forces and with the overall command and control systems. Energy matters will remain an interest of the Department of Energy, and so forth down the spectrum of marine activities.

In this context then, for the operational purposes of this analysis, we have adopted the following forecasts as the most probable and relevant bases from which to start:

- There will continue to be a Coast Guard as an operational entity within the executive department of the federal government. It will emerge as the federal government's lead agency with regards to marine safety and law enforcement.

- There is a high probability that this Coast Guard entity also will emerge as the leading agency, in conjunction with the Department of Defense, for development and operation of a unified marine surveillance system.

- Though the ultimate placement of the functions are still much in doubt, at least during the next decade, the Coast Guard will emerge as the leading expert/agency of marine inspection activities, especially as such inspection relates to the issue of compliance with laws.

- The military role of the Coast Guard will grow in significance and importance, and will become a more significant mechanism for effective linkages in various areas of operation and responsibility. The President and the Defense Command structures will use this capability as an instrument of more selective discretion in tailored responses to various incidents within the marine environment.

The particular objectives which are sought by the federal government vis-a-vis the marine environment essentially include the following:

- To have equitable and developmentally balanced employment and allocation of the marine environment among multiple uses and users, and in complementary support of national needs and objectives.

- To have only safe vessels, platforms, or other operating units on, in, or under the sea.

- To have only qualified operators of each operating unit within the marine environment.

- To have each vessel or operating unit know the significant characteristics of its immediate operating environment (in both present and projected locations).

- To have defined routes and areas of marine operations secure from undue threats.

- To have safe and nonlimiting conduits or spans for transportation through, under, or over the marine body, i.e., pipelines, cables, tunnels, bridges, and causeways.

- To have adequate, effective, and safe ports and facilities for maintenance and service of both onloading and offloading.

- To have effective traffic control, use control and applications of procedures for maneuvering or operating within the marine environment.

- To have cargo extracted, processed, or transported only in a safe and legal manner.

- To have only safe and legal injections into the marine environment.

- To have effective means of neutralizing effects of accidental or deliberate injections, i.e., coping with "ecological distress."

- To have effective means of neutralizing effects of human and hardware distress.

- To sustain effective foreign relations and interfaces, including freedom of the seas, and appropriate regulation of development/exploitation of marine resources.

- To have effective interface with military needs, and to have needed marine-oriented military capabilities.

- To have effective and appropriate overall institutional structures and mechanisms, both public and private.

- To have effective management systems within the individual institutions to assure quality performance within the marine environment.

The above objectives have to do with capabilities and organizations in the private as well as the public sector. Hence, the governmental roles and objectives are facilitative, directional, and supportive as well as operational.

- Thus, the Coast Guard military role will grow in its importance as an instrument of national policy. An agency which can be operational within both the civilian and military context will grow in value.

- In all responsibilities and assignments, the Coast Guard will remain essentially a supporting type agency, i.e., the requirements laid upon it will be evolved from activities outside the Coast Guard itself. Thus, the Coast Guard will remain a service agency and will not become, for example, a marine resource development manager. Also it will not become the agency responsible for determination of, say, environmental quality standards, although it will enforce the standards and regulations made by other agencies.

- In this sense, the focal integrating functions of safety, compliance, and enforcement will serve to forge the Coast Guard into an increasingly significant advisory or consultative role to other agencies (public and private).

- This integrating role initially will be the mechanism through which problems of multiple use become focussed, and through which some form of sea zoning concepts will become necessary and articulated. Safety will be the primary theme of organizing multiple use areas.

- Present missions will remain within the Coast Guard responsibilities for at least the next several years. They will remain an element of some governmental responsibility even if relocated organizationally. Hence, current program managers properly are expected to have plans and developmental programs consistent with the forecasted requirements. This is true whether or not they are still a part of the program responsibilities of the Coast Guard in, say, 1998.

GENERAL IMPLICATIONS FOR THE COAST GUARD

TERRITORY

We expect that the territorial waters of the U.S. will be expanded as offshore resources are developed. It is likely that these extensions will occur evenly, but they may entail some variable distances from shore, depending upon the locales of activities within waters that are today considered to be international waters.

We expect both U.S. ships and foreign ships will be operating in new areas as economic operations emerge within the international waters.

Challenges to freedom of the seas for economic development and rights of passage will create demands for the Coast Guard to operate outside the formally declared U.S. territorial waters. It will be more productive in many instances to use Coast Guard rather than naval power for such apprehension or strategic display of force in instances where the use of the Navy would enhance the probability of a more serious "international incident."

INTERNATIONAL ACTIVITIES

There will exist a greater variety and quantity of international treaties which bear directly on C.G. responsibilities. These will involve enforcement operations within U.S. waters. They also will involve the C.G. supply support and capability to international organizations or pacts for enforcement outside U.S. waters. Some of these treaties will involve prohibition of antisocial technologies and others will relate to exploitation of underwater resources. In both situations, there will be requirements for subsurface operational capabilities and surveillance.

Coast Guard assistance to allies and other foreign nations with regard to underwater activities also will be a significant factor. Nations throughout the world will be experiencing the need to develop similar capabilities as the world offshore resources are exploited.

MILITARY CAPABILITIES

As the arms race continues and enters its next plateau, and as the Navy undergoes the transition toward becoming a subsurface navy, the problems of increasing efficiency of investments will become even more significant than at

present. This trend will couple with the growing problem of indistinguishability between military and nonmilitary applications of antisocial technologies to provide pressure for more effective integration of military and nonmilitary operations. The need to demonstrate military capability other than the strength exemplified by the U.S. Navy will be required by the Coast Guard in various types of marine encounters, for example, enforcement of rights of passage or apprehension of foreign vessels, and perhaps even for demonstrating a show of force toward a nation's vessels.

It seems highly probable that the Coast Guard will become a more important component of the overall force balance. This will entail a constant maintenance of clearly-defined operational missions under varying levels of national energy and mobilizations. and under varying forms of international encounters. At the same time, increased budgetary allocations for military purposes will become politically desirable both internationally and nationally.

The capability for integrated command and control of operations during peacetime will become important in order to have the greatest range of selective application of show of force.

The Coast Guard will have to develop a capability for subsurface operations. The institutional inertias of the Navy in undergoing the transition toward subsurface capabilities will create a situation in which the Coast Guard more easily can assume the lead for some of these developments. Closely interrelated research and development programs will be undertaken with the initial hardware of some subsurface operational units being produced for assignment to the Coast Guard. It will be more important during these times for the C.G. to act with extreme discretion, and to sustain well serviced mechanisms for coordination.

It also will be likely to be a best investment strategy to begin the C.G. equipment specifications and requirements with their long term forecast military role/support requirements. It seems far more likely that equipment designed for these military capabilities can "double" into the capacity for nonmilitary operations rather than the converse.

The Coast Guard military responsibility will be protection of the coasts and ports of U.S. territory against aggression, invasion or illegal applications of antisocial technologies. U.S. naval power will be utilized more extensively and will assume the responsibility for operational defense against aggressive nations whose equipment or devices cannot be dealt with successfully by Coast Guard capability.

These responsibilities will lead to a jointly operated/manned surveillance system designed to serve the command and control of military or nonmilitary specific equipment. Some forms of encounter will make it wiser, in times of nondeclared hostilities or states of war, for the Navy capability to be operated under the direction of the Coast Guard Commandant rather than the Secretary of the Navy or the Joint Chiefs of Staff. This flexibility of either military or nonmilitary agency response and control will be an important instrument of international politics and policy. The President will have the capability to direct whichever form of application seems most suitable for given events and occasions.

Toward the end of the century and into the next century, as the Navy completes its transition toward the subsurface emphasis, the Coast Guard will continue to have need for a significant surface operational capability. Some of the surface vessels used and developed by the Navy during its transition will be suitable for transfer into the Coast Guard, especially in light of the fact that they will be smaller. This will result in effective resource management and it also will slowly create the situation in which the Coast Guard may have the vessels most suitable for a traditional type of "show of force," especially if it involves some of the lesser military powers. In general, these circumstances would entail surface rather than underwater capabilities.

PROTECTION OF PROPERTY AND LIFE

Against Application of Antisocial Technologies

Since the ability to discriminate between military and nonmilitary sabotage applications is virtually impossible, the CG will assume the leading responsibility for protection of this type. As was discussed previously, these efforts will be closely coordinated with the military capability in some situations, including joint operations of surveillance, command, and control.

There will be an increasing priority and demand for an effective "Antisocial Technology" Protection System; especially in the nonmilitary context. The CG will be the likely designee for the lead agency responsibility, as a component of its role as the primary federal agency involved with offshore safety. Since most nonmilitary applications of antisocial technology will occur through subsurface means, this will have a direct impact upon the underwater activities.

The first requirement of this responsibility will be the development and operation of a comprehensive threat identification program. This program will be the following:

- A constantly maintained manual describing the range of specific antisocial technological applications of a nonmilitary nature which can potentially occur
- An intelligence process whereby some assessment estimates can be made of the probability of occurrence, conditions of occurences and source of the application
- An effective preventive system to preclude the potential threat from arising. This will include careful attention to means of reducing vulnerability (an adaptation of the principle that probability of use goes down as the capacity to achieve the desired results goes down)
- An effective surveillance system to determine that a threat is present
- An effective proactive response capability to intercept the threat before delivery is completed
- An effective response system to minimize the effects of an actual application

In this context, attempts to smuggle goods (including drugs and illegal items) or persons will become defined appropriately as an application of an antisocial technology.

For the next two or more decades, this requirement will entail an extensive and dynamic research and development activity in terms of the "protection/threat

race." This program will need to be a closely coordinated activity with various other governmental agencies and private research institutions.

Equipment standards and zonal controls over the spacing and scale of marine activities (especially underwater activities) to reduce vulnerability will be important elements of this protection system.

Against Damage from Natural Disasters

The responsibility to forecast a potential natural disaster will be an important part of any protection system, but it will most likely be assigned to other agencies such as the Weather Service and the Geological Survey. The Coast Guard will have direct access to these forecasting agencies and will be notified promptly of any potential natural disaster. The Coast Guard then will be viewed as the action agency to respond if the disaster cannot be prevented through some other form of controlled intervention. These "intervention capabilities" also will be assigned to agencies other than the Coast Gaurd, although the Coast Guard actually may execute the desired action by prearranged agreement. For example, if a tropical storm is amassing and is to be neutralized, a Coast Guard aircraft may be used to deliver the necessary ingredient.

However, for purposes of this analysis, it is reasonable to assume that the CG involvement in most circumstances will be after it has been determined that preventive intervention is not possible because most of the preventive controls are still beyond the horizon of this forecast period.

The major actions available to the CG will be evacuation and securing facilities or "battening down." Instruments needed to execute these responsibilities effectively will include:

- Equipment specifications/standards for all equipment operating within the underwater environment to withstand damages.
- An inventory of all offshore facilities and activities to be warned
- Zonal controls of activity to reduce vulnerability
- Evacuation of personnel, including the possiblility of evacuating into submersibles or submerged shelters which will provide safety from some natural disasters.
- A communication system to provide warning and instructions
- A recovery system to move in fast for rescue, restoration and possible salvage operations

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Against Accidents Related to Human Activities

As the offshore resources are developed, as operations move under the surface, as multiple operations become closer in proximity, and as the range of potentially dangerous cargoes and the size of vessels increases; the vulnerability to and probability of major accidents involving possible damage to property and life will increase dramatically. Accidents posing environmental pollution problems are also much more probable. The current accident prevention programs will need expansion, especially as they relate to underwater activities. Among the instruments to be developed and/or employed are:

- Effective means of traffic control in selected areas
- Effective equipment specifications and standards
- Effective training programs and mechanisms to assure that operational personnel within the underwater environment are competent to execute their jobs properly
- Adequate communication systems and "tracking" systems to monitor the presence and level of activity of individuals in selected areas
- Effective surveillance and communication systems to determine that an accident has occurred
- Effective response mechanisms for search, rescue and restoration

In view of the yet unknown nature of the "risks" and consequences associated with underwater activities and with the accidental injection of many forms of cargo into the marine/underwater environment, the underwater safety arena will be a vitally active area of responsibility and action.

Of particular concern within this area will be more effective forms of salvage programs. Protection of sunken assets will be important as well as the monitorship and conduct of actual salvage operations.

Some General Points

All of the above requirements will pose serious policy questions: How much of the responsibility should be governmental and how much private? How much can be delegated to state or local governments and how much should and must remain federal? What are the forms and mechanisms which will combine all of these diversified responsibilities and activities into a comprehensive protection system?

There will be a strong tendency on the part of the CG to await the issues and to resolve them in a pragmatic, reactive style. The probability of serious embarrassment to the CG and even the threat of dismantlement of the organization are serious potentials resulting from such a posture. This will be especially true in the

area of antisocial technologies and major accidents. As events occur somewhere in the world, major public concern and demands for effective action will emerge. If the CG is perceived in this climate as having been negligent, it will provide a foundation for "putting the responsibility" into another organization. A concurrent development of dismantling the CG as an integrated operational unit would have increased probability.

There will be a tendency within the CG to have much of the onus for protection placed within the private sector, and onto the individual operators within the underwater environment. This strategy probably will be feasible only for a few more years. After that, the scale and diversity of operations will have reached the point where integrated protection is clearly more cost effective and efficient. The fact is that protection and security will be so strongly demanded that a "marine police force" concept most likely will emerge. An anology to the land-based police force will be appropriate. There may be some private augmentation under close supervision and coordination, but the police power essentially will remain a governmental power and responsibility. An underwater law enforcement component will become an important element in the overall systems of protection.

Still another important policy question will be the decision of what forms of equipment standards should be required, and how those standards can be enforced. All of the pressures associated with insistence upon incremental equipment requirements for purposes of safety and compliance with public responsibilities and needs will be operative in this domain. Inspection and surveillance of compliance in terms of both equipment and operational procedure will be an important capability, and one which is relatively underdeveloped at the present time.

An underwater equipment/operational procedures standards system will be an important component of the protection requirements.

Other significant policy questions will arise from the viewpoint of the relationship among various operators, operations and activities. Scale, density and multiple purpose activities will create special safety problems in some areas, especially underwater. The safety requirement is the common thread through which the various agencies and interests must be ultimately coordinated. Thus, the relationship between safety, traffic and activity control (both of access and operation) and use level/density/purpose are important requirements. The CG will need to evolve an effective system of sea zoning and effective application of the zonal concepts. Different protection systems will be needed and employed in different "zones."

UNDERWATER SURVEILLANCE, NAVIGATION AND COMMUNICATION

From the aforementioned conditions, it is evident that a sophisticated and highly effective system/capability for underwater surveillance, navigation, and communication will be increasingly important. There will be many actors involved in various forms of underwater monitoring and surveillance. These will vary from scientific research teams to underwater oil rig teams involved in maintenance of underwater equipment and facilities. Many public and private agencies will be involved in this process and function. It will become rapidly clear that a single service agency for underwater surveillance, navigation and communication is the most cost effective way to fulfill these requirements. There probably will be a significant national debate over what form this agency should take. A key factor will be the clear redundancy among the systems operated for national defense purposes, those operated for protection and safety purposes, those operated for recreational and commercial purposes, those operated for scientific purposes, etc. We think it is highly probable that if the CG has developed its capabilities consistent with its requirements, then the CG will be designated as the agency to operate an integrated underwater surveillance, navigation, and communication system. This system will be designated as a multiple service to public and private organizations. It will be directed to be developed and operated in close coordination with, but in addition to, the system used for military defense and security.

The basic requirements which this "system" will fulfill include:

- The capability to determine who is operating where and for what purpose
- The capability to direct and control activities as required for assurance of safety and compliance with required equipment and procedural standards
- The ability for everyone operating within the marine environment to know where they are, what other activities are going on within their proximity, and what they can and should do in the way of movement and activity
- The ability to determine that a threat or an emergency condition exists, to determine where it exists (including tracking of any movements associated therewith) and to direct appropriate responses and response teams to the scene and through their operations
- The capability to determine injections which occur illegally or accidentally, and to direct the appropriate responses thereto

COAST GUARD UNDERWATER CAPABILITY

The previously stated events indicate the need for an extensive and well developed CG underwater operational capability. This operational capability will need to provide effective coverage across the entire range of underwater missions and requirements. These will include at least the following:

- Development and maintenance of underwater navigational systems and aids
- Conduct of underwater patrols/surveillance activities
- The ability to apprehend underwater threats from antisocial technologies, illegal behavior, malfunctioning equipment, negligence or other sources
- The apprehension capability will need to include the capacity to effectively handle varying problems, e.g., boarding, containment, escort to surface, destruction, etc.
- An underwater location and rescue capability
- An underwater inspection capability
- An underwater maintenance and logistics capability
- Public education/training programs

The unique nature of the underwater operational world will most likely require that these underwater operational units be a specialized core/cadre of equipment and personnel that can respond in an effective and integrated fashion to all of the requirements.

OTHER PROBLEMS TO BE ENCOUNTERED AND RESOLVED

There are a variety of other problems associated with the forecasted underwater developments and activities which do not fit into the above categories in a direct fashion. These areas are outlined in this section.

Problem of Determining Integrative Activity Implications/Assessments

It is now conventional wisdom that any activity often provides unanticipated consequences in both the short and the long term. It is also perceived that when activities become interrelated, the total consequences and effects are "synergistic," i.e., the whole exceeds the sum of the individual parts.

These realities call for new forms of analysis which are more organismic and dynamic in nature, more holistic in scope and longer term in perspective.

As the inventory of potential underwater activites grows, and the resource development opportunities become more defined, it will become increasingly necessary to have a capability to assess what the overall long term and interrelated effects of such activities will be if pursued in concert.

Since safety, compliance and law enforcement are the common threads through which all underwater activities are bound, the agency having this responsibility is the agency where this analytical capability should rest.

Along with this analytical capability will go the extraordinary capacity for policy evaluation and strategic assessment of various underwater developmental trends. The equivalent of socio/technological assessments are a logical output of such a system. Some form of coordinated clearance and policy body for approval of given developmental/activity strategies is an appropriate instrument through which to make these decisions.

The CG likely will be viewed for some years as the potential leader in developing this capability. However, should the CG not fulfill this leadership role, the void will be seized rapidly by other agencies as an opportunity for "bureaucratic entrepreneurship." Loss of this leadership and role would impair seriously the effectiveness of the CG to carry out its other operational missions and responsibilities.

Problems Associated With Division of Responsibility Between Standard Setting, Inspection, and Enforcement

The present diversification of responsibility for various forms of developmental policies and environmental standards is expected to continue. For example, the Environmental Protection Agency will likely remain responsible for determining qualitative environmental standards. They and others will probably be the source for evolving concepts of positive management of injection into the underwater environment. Other agencies (within or outside of a "Marine Affairs Department") but external to the organizational scope of the CG will continue to be responsible for various other operational standards associated with the types of economic or recreational activity being undertaken. However, CG is likely to be the agency at the focal point of all activities by virtue of the safety, compliance, and enforcement roles. Thus, the requirements for CG operations, and the degree of effectiveness with which those operations can be executed, can be heavily determined by these external standard setting agencies. Improved means of integrating the CG perspectives of standards, integration and enforcement procedures with these agencies who determine them should be pursued.

A future oriented assessment/impact capability will be especially important. The type of analysis discussed in the preceding section could become a vital means of fulfilling this requirement.

Problems of Establishing an Effective Sea Zoning System

Many of the requirements and forecasted developments underline the need for some form of sea zoning plan and process. The development and evolution of such a system is not within the clearly defined assignments of any current agency. Yet, the fact that such a system is so entwined with the preceding types of CG requirements, and the CG roles which provide the focal points where these issues converge makes it a priority need for the CG to take some form of leadership in developing such a zonal system or concept.

The CG is already moving with some experimental analysis in this direction. We expect that such efforts will be continued and that the underwater aspects of the overall systems will be important.

Problem of Precluding a Major Coast Guard "Embarrassment" or "Scapegoat" Issue as a Result of Incapacities and Inactions Being Spotlighted by a Major and Dramatic Event and Related Follow-On Investigations

The development of effective capabilities to deal with the requirements associated with the underwater activities will most likely lag behind the activities themselves. This will create a situation ripe for dramatic occurrences such as in the area of protection against antisocial technologies. Some radioactive leakage from underwater storage cylinders is a good candidate. A blowout of a LNG tanker or a variety of other chemicals not unlike the current issues arising from rail accidents is still a third potential.

The Coast Guard, among others, will be in for a series of appearances before investigative hearings both within the Executive and Congressional arenas.

If the traditional esprit-de-corps and solid reputation of the Coast Guard is to remain intact, it will be important to have clear rationales for what has been attempted, what has been recommended, what is underway, etc.

SUMMARY

The preceding are the very major overall implications which will comprise the essential dynamics within which individual CG program requirements will emerge. A summary of this vignette, along with time phased probability estimates, is contained in Figure 3-1. We now turn to a recasting of these broad implications into an outline of implications for each of the current CG programs.

FIGURE 3-1: TAILORED VIGNETTE: GENERAL CG IMPLICATIONS

POTENTIAL DEVELOPMENTS	PROBABILITY/TIMING		
	1981-85	1986-92	1992-2000
TERRITORIAL WATERS WITHIN JURISDICTIONAL CONTROL OF THE U.S. ARE EXTENDED SELECTIVELY BEYOND THE 200 MILE ZONE	M	L	G
CHALLENGES FOR FREEDOM OF SEAS CREATE DEMAND FOR CG TO OPERATE OUTSIDE THE U.S. TERRITORIAL WATERS AS ESCORT TO GUARANTEE PASSAGE	G	H	H
UNILATERAL AND BILATERAL TREATIES INVOLVING REQUIREMENTS FOR UNDERWATER CAPABILITIES WILL EMERGE IN INCREASING NUMBERS	G	H	H
REQUIRED CG ASSISTANCE REGARDING UNDERWATER ACTIVITIES TO ALLIES AND FOREIGN NATIONS BECOMES INCREASINGLY SIGNIFICANT ACTIVITY	G	H	H
CG MILITARY CAPABILITY BECOMES MAJOR COMPONENT WITHIN OVERALL FORCE STRUCTURE OF U.S. MILITARY CAPABILITY	L	H	H
CAPABILITY FOR INTEGRATED COMMAND AND CONTROL OF OPERATIONS DURING PEACETIME OF BOTH NAVAL AND CG CAPABILITIES THROUGH EITHER THE JOINT CHIEFS OF STAFF OR COMMANDANT OF THE CG BECOMES A REQUIREMENT	M	L	G
CG EQUIPMENT INVESTMENT STRATEGIES CHANGED TO BEGIN WITH BASE OF MILITARY CAPABILITIES	L	H	H
CG MILITARY CAPABILITY FUNDED DIRECTLY AS COMPONENT OF CIVILIAN BUDGET	G	H	H
ADEQUATE SYSTEM FOR PROTECTION AGAINST ANTISOCIAL TECHNOLOGIES BECOMES A MAJOR PROBLEM AND A DEFINED REQUIREMENT	G	H	H
GENERALLY EFFECTIVE OVERALL PROTECTION SYSTEM FOR UNDERWATER ACTIVITIES AND RESOURCES BECOMES A SPECIFIC REQUIREMENT	G	H	H
REQUIREMENT/ASSIGNMENT TO BECOME LEAD AGENCY TO DEVELOP AND OFFER, AS A GENERAL SERVICE, A UNIFIED UNDERWATER SURVEILLANCE, NAVIGATIONAL AND COMMUNICATION SYSTEM	M	L	G
REQUIREMENT FOR EXPANDING UNDERWATER OPERATIONAL CAPABILITY DEFINED AND CAPABILITY BECOMES ON-LINE	L	H	H
REQUIREMENT FOR CAPABILITY FOR INTEGRATIVE POLICY EVALUATION OF VARIOUS UNDERWATER DEVELOPMENT PROGRAMS AND ACTIVITY PLANS	G	H	H
REQUIREMENTS FOR EFFECTIVE SEA USE PLAN (UNDERWATER) AND RELATED ZONING CONTROL AND SEA USE CONTROL SYSTEM/PROCESS IS DEFINED AND MADE OPERATIONAL	L	H	H
MAJOR CG "EMBARRASSMENT," ACCUSATION OF NEGLIGENCE, AND DEMORALIZATION FROM BEING "SCAPEGOAT" OR SHOWN TO HAVE INADEQUATE ANTICIPATORY MANAGEMENT OCCURS WITH SUFFICIENT INTENSITY TO HAVE SERIOUS IMPLICATIONS FOR THE CG MISSIONS, ROLES AND ASSIGNED RESPONSIBILITIES	G	G	L

KEY

L = low G = good
M = medium H = high

CHAPTER 4: IMPLICATIONS FOR COAST GUARD CURRENT PROGRAM STRUCTURE

INTRODUCTION

The last chapter dealt with overall implications for the Coast Guard. This chapter extends the analysis to more specific implications for each program within the current program structure.

Implications for which there were no direct program implications are outlined in the next chapter

Analysis of the specific programmatic implications follows the same principle as for the general implications; they are viewed as requirements which will have significant impact on the specific program. This articulation of anticipated requirements does not imply a judgment as to the degree to which capabilities for meeting these requirements currently exist, are under development, or are being planned for development. Rather, this chapter should be viewed as a continuation of the tailored vignette for CG implications.

SHORT RANGE AIDS TO NAVIGATION

It will become necessary for the Coast Guard to develop a system of underwater navigation and related short range aids. The specific type of instruments will vary with the locale, the purpose of demarcation, and the types of underwater activities to be encountered.

As the underwater activities develop, an effective form of underwater navigational system will become essential. The objectives of this system will include:

- Integration with surface navigational systems to denote areas in which both subsurface and surface activities are occurring with the possibility of overlapping depths.
- Marking of underwater facilities (fixed and mobile) in some manner which will identify the type of facility, including pipelines, cables, rigs, etc.
- Marking of underwater transportation channels and other areas of restricted access/use. Park boundaries, underwater channels for various submersibles, underwater trails and recreational pathways, etc. will all require some appropriate means of demarcation.
- Aid for determining location/fix. This will be especially important in the crowded areas of the continental shelfs

The types of equipment will include:

- Unmanned mechanisms operating from self-generated power using the movement of the sea as the energy source. Battery power will be utilized on a selective basis
- Passive and active types of instrumentation
- Visual, radar and sound devices as means of recognition
- "Anchoring mechanisms" will include mechanisms that are stationed to observe the bottom either directly or by hooking to a line/cable
- Some mobile navigational aid stations are also likely to be controlled by both remote and manned means

The underwater navigational system will be integrated with and be an operational component of the overall underwater surveillance, navigation and communication system.

RADIO NAVIGATION AIDES

The underwater navigational system will make extensive use of radio. Sound transmitters will be a component of the short range aids, but they will also be a major feature of longer range navigational assistance.

Objectives of radio navigation will include:

- Assistance in acquiring a fix on location; short range radio transmitters will be used as well as long range transmitters. The limited range of radio through the water will likely create a need for a network of subsurface, surface, air borne or satellite sending, receiving or transmitting stations.
- Identification of authorized presence as a means of efficient patrol for the system of protection. Persons or vessels operating without authorization or in unauthorized locales can be identified immediately by appropriate sound emissions. Unidentified vessels could be discovered for further investigation
- Signals for distress and aides for search/rescue operations; radio navigation instruments can provide a homing-in capability for location of the vessel.
- Identification and tracking of various other activities such as ocean currents, animal mobility and movement and various other scientific or operational activities

It is likely that development of some fixed and mobile underwater radio stations will be needed. Fixed stations will be highly restricted for application in such areas as ports. Most such underwater facilities will be in submersibles so as to be mobile whenever required.

ENFORCEMENT OF LAWS AND TREATIES

As offshore resources are developed and as underwater activities associated with such developments expand, there will be a major increase in the number and the complexity of laws and treaties with which the CG will be required to participate.

Problems of securing U.S. operational passage and freedom through some areas is an area of high concern. It is likely that the CG will be deployed for some such actions rather than the Navy (see discussion of military capabilities in Chapter 3.)

Individual nation agreements for various resource exploitation rights will emerge. The relative amount of such activity will slowly shift below the surface, making surveillance and apprehension capabilities within the underwater environment a prerequisite of enforcement.

As marine resources--especially agriculture and minerals--are developed, they will become important goods for export. In more and more instances, foreign vessels will be permitted access to such resources by specific agreement. These agreements will have terms and conditions for which compliance will need to be independently monitored.

As the resource exploitation becomes a means of positive trade, the concerns for accurate estimates of the amount of resources exploited will become important.

Effective protection systems against antisocial technologies are destined to become a vital aspect of law enforcement along with treaty negotiation. Rights of access and purpose will be unilaterally negotiated with different nations in a growing number of circumstances.

Problems from accidental pollutants and from dangerous cargoes will become an increasing aspect of law enforcement as well as for treaties. Vessels not meeting certain standards which will be prescribed will be precluded from operation within U.S. waters.

Underwater inspection capabilities will be required to determine compliance both in terms of equipment, methods of operation, and the operations themselves.

MARINE ENVIRONMENTAL PROTECTION

Underwater activities and injection mechanisms plus the continued diversification of dangerous cargo will act rapidly to increase the requirements of environmental monitoring, surveillance and protection.

The most direct impact upon this program will be the need for underwater operational capabilities.

Extensive analyses to determine the operational specifications for equipment operating beneath the surface will be needed to assure that accidental injections of pollutants are minimized. Capabilities for underwater inspection of equipment and operations will be essential.

The evolution of the concepts of positive waste management and employment of the offshore areas as natural waste disposal systems will add new and different dimensions to the type of monitoring which will be necessary.

Dredging and underwater mining operations along with new forms of operational equipment that will be employed will present major responsibilities in the areas of inspection and monitorship.

The demands for various forms of clean-up will grow. The number of agencies with whom coordination will be necessary will increase, both in terms of public and private organizations.

In at least some areas, international agreements on marine environmental quality can be expected. Joint responsibilities for monitorship of such treaties will likely be shared among the nations involved. Of particular interest in this area will be those waters which overlap a 200 mile limit, such as some areas of the Gulf of Mexico, the Caribbean, and the Atlantic and Pacific Coasts near the Canadian and Mexican borders.

Increasingly, there will be a subtle shift from a concentration on prohibiting pollution and cleaning up spills toward concepts of marine quality maintenance and management. Clean up techniques will shift gradually from removal toward neutralization. Some underwater parks will require specialized surveillance and patrol capabilities.

An eventual requirement will be for a complex specialized manual, defining all potential forms of pollutant/degradation circumstances, and giving appropriate actions to be taken in each case. Dangerous cargoes will be identified, and their effects on the marine environment, should they accidently be discharged, will be determined and remedial measures will be formulated.

COMMERCIAL VESSEL SAFETY

The most direct impact on this program will originate from the need to establish a commercial vessel safety system for underwater vessels. This system will have all of the features now present for surface and air vessels.

The differing domain and specialized nature of underwater activities will make it likely that none of the substantive technical standards and manuals now used for surface and air vessel safety will be transferrable to the underwater realm. The system will need to be specialized to the underwater operational environment.

The next impact will be the significant increase on the sheer volume and types of vessels involved.

There will be a need for at least some visitation and observation of underwater operations.

DEEPWATER PORTS

As the activities emerge, the concept of deepwater ports will undergo significant change. Concepts of connecting such ports to offshore mining and resource production will require many additional analyses and requirements. Ore slurry pipelines will be adapted from the oil pipelines design.

As the single mooring points give way to full-fledged floating platforms for handling materials, and as these in turn are supported by logistical facilities, including possibly underwater quarters, the overall requirements and responsibilities for deep water ports will be significantly changed. These systems will require increased underwater monitoring and inspection.

Underwater operational capability will be required to assure compliance and enforcement with standards and with operational procedures.

Studies to determine acceptable locations and types of deep water ports will be needed.

PORT SAFETY AND SECURITY

The increased number of underwater vessels will potentially have an impact on port safety and security. Either rules will mandate that all entry and exit be via surfaced vessels, or there will be underwater transportation taking place.

Perhaps the most far reaching implication is the fact that most of the nonmilitary applications of antisocial technology are delivered via underwater means. If various nations or groups wish to do so, they can make a port a target for sabotage or aggression.

Existence of the threat of such events will cause some form of port safety systems to be developed, using both underwater surveillance and intercept equipment. In addition, the underwater navigational system will require attention in and around the port areas.

As underwater vessels become common, the joint use of surface vessels and underwater vessels sharing the same "sea space" will bring on significant problems of safety and requirements for traffic control procedures.

Although not related to just the underwater developments, an important future aspect of port safety and security is the anticipated demand for additional ports and port facilities. As these demands emerge, and as some mass underwater transportation and other new uses become a reality, the requirements will increase for underwater safety elements and review of alternative port sites. A demand and/or requirement for underwater docking facilities will occur toward the turn of the century.

It is unclear whether the underwater logistics stations will be considered an extension of ports. Servicing that now is done in port facilities can and will be located offshore. Development of appropriate safety rules, regulations, equipment specifications and operational procedures associated with such activities will be required. It is a logical extension of the responsibilities of port safety and security.

The development of an effective surveillance system for protection against antisocial technologies, and of an effective response system to the accidental injection of foreign materials into the underwater environment, plus the dealing with underwater operational capabilities will be the primary sources of impact upon this program responsibility.

SEARCH AND RESCUE

Underwater operations will require a specialized search and rescue system. This involves the ability to locate and acquire access to underwater vessels and facilities and to emit distress signals.

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Specific rescue requirements might be facilitated by equipment design standards which assure a compatibility of the facilities to gain access within the underwater environment.

In general, it seems appropriate to anticipate the need for a specialized underwater search and rescue function within this program. Substantial research is needed before the specifics of the program can be outlined.

The SAR functions, however, can be more effectively built into the other CG requirements. For example, the requirement to operate movement control. surveillance, navigational and communications systems opens opportunities for greatly reducing the search requirements. Locations can be more easily fixed through these systems and their constant monitorship.

Rescue, however, is a different matter. The rescue requirements will range from the equivalent of the ambulance to retrieve an ill operator to the crash rescue squad which is required to enter a damaged and rapidly filling underwater vessel of facility. Rescue may not include just evacuation. It may include auxiliary equipment to prevent an aggresive threat. In this perspective, "rescue" of a facility threatened by an explosive device floating toward it in a camouflaged mine might occur by interception of the device, by early detonation in a neutral area, by evacuation of personnel and equipment, or by a variety of other techniques.

Rescue of a flooding chamber in either a submersible or an underwater facility might include the ability to inject air at a pressure to curtail the flow while making emergency repair of the rupture, and then pumping out the facility. Emergency mobile medical facilities of an underwater type are a distinct possibility. Search and rescue events will not occur often but will be dramatic in nature, and will demand a quick response capability.

MARINE SCIENCE ACTIVITIES

Ultimately, we would expect that there would emerge an agency responsible for monitoring the total marine environment. We have already forecast that surveillance and related monitoring of movement will be a Coast Guard function. Scientific monitoring, in our view, will ultimately be assigned elsewhere. This monitoring system will include extensive application of underwater instrumentation. It will also monitor the composition of the underwater environment and various marine phenomena.

The primary impact of the purely underwater developments upon the Coast Guard will involve the Coast Guard responsibility that these underwater science instruments be properly marked and that they function effectively and safely. The monitorship/instrumentation agency may also wish to procure "tending service" of the system from or through the CG. Such a policy would make use of the capabilities of the CG for operation within that area.

The CG will be an important user of the information developed by scientific monitoring systems. Such data will be used to help detect subliminal delivery of antisocial technologies, violations of various forms of environmental quality standards, and operational safety of various areas under changing conditions of underwater movements.

(Note: This program does not include the CG-related research and development which is discussed under another category.)

Within the next five years, however, the Coast Guard will be called upon for a much more active science support program. For example, assistance in developing the concepts of positive waste management will probably be welcomed and perhaps required. Positive management of marine agricultural activities, and of the related range of resource development possiblities is still another area. Monitoring of the marine life and movement patterns, of the populations of fish, and of the readiness of the various "managed grounds" for harvest are activities which could be natural offshoots of Coast Guard operations and far more cost effective if the Coast Guard were used.

The degree to which the CG does become involved will be heavily affected by the degree of leadership and initiative which it takes in advancing some of these concepts, and in offering its services in this regard. Cooperative initiative with various other public and private organizations involved will probably lead to a significant involvement in marine science activities. Such a pathway could pay real dividends in savings through more effective use of resources, and through effective linking to the extensive R&D needs and operations of the CG.

RECREATIONAL BOATING SAFETY

There will emerge an underwater counterpart to recreational boating. It will include recreational diving in submersibles and advanced scuba equipment. Parks, some underwater restaurants and observation points are a component of this underwater recreational activity.

Underwater traffic control and control of certain restricted areas from recreational use (such as underwater oil fields) will require an expanded capability to monitor operators, locations, and activities.

We would anticipate that this program will be expanded and have more responsibility for marine recreational activities. This will either include the entire range of underwater recreational facilities and activities, or it will be dismantled as a separate program and absorbed into other program functions. In either event, an underwater operational capability will be needed to effectively carry out this monitorship of underwater recreational safety.

There will be a major program of equipment specifications, inspections and investigations as the various new forms of underwater recreational activities and related equipment continue to develop.

Of particular concern within the underwater environment, will be the problem of assuring that only qualified operators are permitted to perform these tasks. The risk of an unqualified person causing an accident will be greater than with surface operations. Also, protection of the person from "straying" into areas that involve personal risk will impose new demands. This requirement will be met by a combination of zonal controls, equipment specifications, procedural training and licensing, and close surveillance and control procedures on the part of the CG.

BRIDGE ADMINISTRATION

There seems to be little direct impact upon this program resulting from the outcome of the forecasted underwater activities, although aspects of more conventional marine operation will be impacted significantly.

Movement of underwater vessels in channels under bridges will be increasingly frequent. It seems unlikely, though, that these activities in themselves will require specialized consideration and handling from the context of this program.

Safety of bridges from the growing potentials of accidents relating to dangerous cargoes and to the underwater traffic will be areas of concern. Also, safety of bridges from application of antisocial technologies will become a significant concern, although it may be assigned to another Coast Guard program.

MILITARY PREPAREDNESS

The entire area of military requirements will be dramatically affected by the forecasts. Chapter 3 contains a detailed discussion of how we expect these

developments will affect the CG. We anticipate that this program will be conceptually and operationally expanded to institutionalize new approaches for these additional requirements.

As is shown in Chapter 3, the maintenance of up-to-the-minute definitions of the role of the CG in support of the Navy in case of mobilization will be important. Long term military assignment of requirements will become the basis for equipment specification and design. The equipment concepts and design will emphasize the increased military responsibilities.

The CG military capability will become a more integral part of the U.S. military capability. The potential of the CG, assuming the command of Naval equipment and personnel under selected circumstances, will require effective command and control procedures. Joint operations of effective surveillance systems will be an important aspect of the military capabilities.

In general, we would expect this program to be broadened to become the central coordinating point for the entire reorientation of the military role of the CG. It will probably be renamed (for purposes of discretion) as the emergency protection services or something of that nature. The range of emergencies with which it will deal include protection of U.S. coasts and underwater facilities from antisocial technologies. This includes those delivered by foreign military organizations.

Development of effective underwater operational capability and potential leadership in some areas of this type of equipment will be important to this program.

New operational training programs and an entire cadre of differently qualified personnel will emerge.

RESERVE TRAINING

Underwater activities will create a major new area of personnel specialties. All of these specialties will be added to the reserve contingents. Increased pressures of cost and fluctuation of operational requirements will likely enhance the role of the reserve units in general, and for the underwater operational capabilities in particular.

For example, terrorism and sabotage applications will often be via underwater delivery. These types of threats characteristically seem to occur in

bunches. It may not be practical to man regular forces for the peaks of these threats. Reserve forces will be an effective means of providing on call the additional capability.

The reserve units will have to acquire the capability of operating the underwater equipment, and of dealing with all of the facets of requirements which emanate from the development of the underwater resources.

They will need to be instructed in various procedures for protection, emergency services, inspection and perhaps even operational takeover of underwater facilities. They will need to be skilled in underwater logistics and service facilities, and in how to protect as well as maintain the various underwater transportation facilities.

The upgrading of skills associated with the earlier years of new operational systems will be especially significant. Also the rapidly changing composition of the equipment and operational requirements involved probably have an impact upon the quantity of tranining which reserve forces will need.

COMMUNICATIONS

An effective underwater communications system will be of paramount importance. It will be necessary to have some means of effectively keeping up with all operations and operators within the underwater context.

Abilities to demand recognition and to get quick and accurate response will be important. Abilities to communicate impending threats or dangers will prevent a major accident. Location of underwater operators in distress, and the ability to transmit a distress signal will require specialized equipment designed to operate within the underwater world. As was discussed in Chapter 3, an integrated, sophisticated and comprehensive surveillance, navigational and communication system will be required.

Achievement of the communication aspect of the system will involve extensive development of communication techniques. Equipment specifications and requirements related to all operational units within the underwater environment, and effective inspection and enforcement programs to keep the overall system functioning effectively will be incorporated as part of an integrated communication system.

An underwater operational capability will be required in conjunction with this communication system, primarily to maintain it and to inspect the communication

equipment of fixed underwater facilities.

Much improvement in the CG command and control capabilities with special attention to underwater command/control systems is a critical factor. (See discussion of command and control in Chapter 2 of Volume 3.)

We would expect that this program will be redesignated from a support program to a primary mission program.

PUBLIC AND INTERNATIONAL AFFAIRS

Underwater operations and activities will become a significant area relative to public affairs. The growing interest in offshore resources and in the activities associated with them will create a demand upon the CG.

In addition, the greatly increased activities in treaty negotiations and the greatly expanding number of countries which are likely to be interested in emerging underwater activities will generate demands for a significant increase in serving international relationships, since it is a new area in which we expect the U.S. to be a world leader. (See discussion in Chapter 3.)

Of particular impact upon the public affairs program will be the series of investigative hearings and related action groups who will be responding to various dramatic events (disasters and accidents) involving underwater operation. The search for scapegoats will be blunted only by effective anticipatory management and by an effective mechanism by which the CG story is told fairly and correctly.

CG involvement in various public interest groups will grow as the underwater activities emerge. Conservationists, resource exploiters, underwater enthusiasts and the evolving underwater industry will need to be served with effective streams of information and materials.

RESEARCH AND DEVELOPMENT

As is true in any new area of such complexity, research and development requirements will be intense and diversified throughout the entire forecast period.

It will be increasingly necessary to link the CG research and development activities into those of other federal agencies and private research groups. Maintenance of effective scientific and technological forecasting systems will

be especially important for the Coast Guard to retain the needed lead time for development of its required capabilities.

The areas of underwater activity which seem of paramount priority at the moment include:

- Development of effective protection systems in all categories
- Development of an effective surveillance system and its conversion into operational status
- Development of an entire new network of equipment specifications related to standards for regulation and enforcement of safety for all underwater operations as well as for CG operations.
- Determining the nature of the CG's required underwater operational capability and moving ahead to begin developing that capability
- Definition of the risks, threats and countermeasures for all potential applications of antisocial technology
- Development of the needed navigational aides for underwater operation
- Development of effective mechanisms and procedures for execution of the underwater missions
- Development of new monitoring devices related to enforcement of positive waste management concepts

These are only illustrations. Since the underwater developments are essentially a newly emerging area of operations, and since it is a diverse and complex specialized domain, an extensive and dynamic research and development program must be sustained if the CG requirements are to be met at all.

PERSONNEL

A series of new skill categories, training programs, and constant updating of programs will be an essential ingredient to the effective capability for dealing with the future underwater operational world.

Every area of personnel recruitment, motivation and training is involved. Special incentives may be necessary, for example, to get personnel to voluntarily operate within the underwater area. Higher skill requirements and a more diversified capability are likely needs. Understanding of psychological and human endurance factors will be elements to be dealt with.

Curriculum within the entire training structure will need to be tailored to underwater operations. The rapid movement of this area will make the maintenance of such curricula difficult for the next two or three decades.

CIVIL RIGHTS

We see no particular implications for civil rights programs which are unique to the underwater activities.

LEGAL

It seems likely that a new and specialized body of marine law will emerge as the offshore resources are developed. Since many of these resources will be involved with underwater activities, it is appropriate to point this out as a direct impact on the forecasted underwater developments.

A variety of new legislation will be needed, but more important will be the necessary administrative law processes and procedures needed to effectively assure CG mission accomplishments and underwater justice.

While much of this responsibility lies outside the CG, we would expect the CG legal staff to be a spearhead and to be called upon for participation in the entire range of emerging new laws.

It is difficult to foresee all of the new laws that will evolve to govern the marine environment's use. A series of challenges to Coast Guard regulations in the courts seems probable. The enforcement of legal liabilities upon underwater operators is another area where significant impacts might be felt. New international treaties and various forms of international law associated with the developing marine resources are still other dimensions.

Establishing procedures and rules for determining negligence, reasonable discretion, assignment of fault in accidents, and determining who to prosecute for what will present novel and interesting legal problems will have implications which bear directly on CG operations.

ENGINEERING

It seems self evident from the preceding discussions that engineering, too, will be affected by the requirements to develop the CG operational capability for underwater activities. Equipment design will be extremely important, both in terms of the CG equipment and in terms of setting standards for equipment to be used by others.

Also of great significance to engineering support is the area of equipment design related to the new dimensions of military capability. It seems reasonable to project that many of the engineering technologies employed within the

underwater environment will qualify as subspecialties, i.e., as fields which require specialized adaptations of general engineering principles and knowledge.

MEDICAL

Human endurance and long range effects of human operations within the underwater environment are not yet well documented areas of medical knowledge. This rapidly growing field will be an area of dynamic concentration for CG medical personnel. At least some dimensions of specialized diagnosis, treatment and medical equipment/facilities can be anticipated.

Extensive psychological and physiological evaluation of personnel operating within the marine environment will be needed as the empirical foundation upon which to build this rapidly emerging field of medical knowledge and expertise.

The implications range from such physiological phenomena as the bends to the psychological and emotional impacts of operating in a new and somewhat strange environment. The impacts upon people will be different. Psychological and physical screening procedures and criteria will be needed. Effective means of determining the degree to which underwater activities has contributed to personnel disability will be a growing need, and probably a specialized area of medicine.

There will be many institutions involved in these pursuits. But the fact that CG personnel will be operating within the marine environment and dealing with rescue and treatment of others who operate in the same environment will make the requirements for CG involvement acute.

INTELLIGENCE AND SECURITY

We have outlined in Volume 3 our forecast that the problems of effective prevention and protection systems against potential threats from nonmilitary applications of antisocial technology will ultimately require more sophisticated and refined intelligence systems. This will be an international intelligence need, and will probably be most effectively executed by tying into other already existing intelligence networks.

The particular types of intelligence associated with enforcement within underwater operational systems will be a growing need, the specific outlines of which we cannot foresee. Close monitorship should be maintained.

SAFETY AND OCCUPATIONAL HEALTH

The essential features of occupational health were discussed under Health Services. Additional specialized safety requirements will need to be determined and specified for inclusion in equipment standards to assure the safety of persons working in underwater habitats and vessels. It seems likely that the requirements will vary with function, depth, and various other factors. A series of equipment and operationally specific safety standards is a likely need. There will also be some generalized requirements, such as the provision of a certain volume of space that personnel can move in if confined within the underwater environment for certain periods of time.

FINANCIAL MANAGEMENT

Although not accomplished in this research project, we have forecast elsewhere a critical period of national re-examination and priority debates for federal expenditures to emerge within the mid 1980's. As pressures to hold down or reverse expenditures and as the battle for priorities emerge, those activities which lend themselves to user charges will be increasingly pressured to develop mechanisms and concepts which permit this form of fund acquisition.

There will be a variety of pressures to bring the service functions the CG administers in the underwater environment into the general philosophy of user charges. For example, the operation of surveillance, navigation, and communication systems will be primarily for those operating in the underwater environment. Some form of prorated charges would be feasible, and will probably be advocated by at least some members of Congress. The CG financial management personnel will be called upon to evaluate new and alternative ways in which the financial aspects of the underwater environment can be handled. Other issues will evolve around various funds such as the current oil liability fund for clean-up costs. It seems likely that this concept will be increasingly applied to many areas of underwater activity.

Revolving fund concepts are still another form of financing in which user charges are generally reallocated to other federal agencies. It is conceivable that certain underwater activities, such as marine science and maintenance of instrumentation systems, might fit this form of financial administration.

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CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the basic conclusions derived from the entire project, and outlines several recommendations for what the research team regards as reasonable and important steps to be taken by the CG in order to prepare for the anticipated developments and implications.

GENERAL CONCLUSIONS ABOUT FUTURE UNDERWATER ACTIVITIES

1. Most of the future activities which will become a part of the Coast Guard's operational concerns by the turn of the century are already emerging or presently are in conceptual form. Despite this current situation, the future developments will create a wide variety of basic discontinuities. That is, the future of the underwater environment will not be one which can be envisioned by an extrapolation or projection of historic trends. For example, the extraction of oil from the ocean bottom which has been projected to increase steadily, could be disrupted by unanticipated terrorist activities. Some projections will provide reasonable insights into selected aspects of this future underwater environment. But the perceptions with respect to that future must be derived from a more complex form of analysis than that of trend projection alone.

2. These discontinuities will stimulate dynamic changes in the manner in which the federal government is organized to execute its roles with respect to the marine environment in general and the underwater environment specifically. As various agencies vie and jockey for management control of the marine environment, the Coast Guard roles and responsibilities will be highly sought after and coveted. There will be an effort to "invade" the integrity of the CG as an organizational entity. Concurrently, the CG may initiate a counter drive for adding significantly to its roles and missions. In the final resolution, it is likely that the CG will lose some of its current responsibilities and assume new ones. It will likely be relocated within a new organizational structure, devoted to Marine affairs, but it should remain sufficiently intact to have the legitimate term of "an agency" applied to it. The themes and roles which will most likely be retained within the CG are those related to safety, law enforcement, and military capability.

3. There will be a number of major and dramatic events which will stimulate a series of investigative hearings, commissions and other special evaluative and investigative processes within the executive and legislative branches. Unless

the CG has practiced an extraordinarily skillful process of "anticipatory management," it is most likely that major embarrassments will accrue to the CG, tarnishing a rich tradition and heritage. Actions, in order to preclude being made the "scapegoat" or being shown to be negligent in matters of profound national interest, must start presently if they are to be effective. Moreover, these efforts must be sustained, and they must be directed with great wisdom, imagination, insight and creative leadership. The tools with which to do this are varied, but many are available. Application of these principles and practices within the underwater environment will be an important component of the overall CG management problem. (Note: We are aware that the CG is taking a number of imaginative steps to develop and sustain effective anticipatory management. Indeed, this project is an example in its own right.)

4. The future underwater activities entail profound and significant implications for virtually every program within the current structure. Moreover, there are some implications which represent, for all practical purposes, new requirements that are not in conformity with any of the current programs

5. The implications are so broad, diversified and complex that special mechanisms for aggressive leadership, development and coordination, are needed if the CG is to be prepared to meet the future requirements in an effective and exemplary manner.

CONCLUSIONS ABOUT PROBABLE NEW REQUIREMENTS NOT CLEARLY RELATABLE TO CURRENT PROGRAM STRUCTURES

1. It will become necessary for the CG to have a diversified and effective underwater operational capability.

2. There will emerge a new role in military capability, which is qualitatively different and significantly more important than today's current concepts of military preparedness.

3. New law enforcement concepts will be invented which entail philosophies related to positive resource development and exploitation. These will complement the restraint/allocation concept which now dominates the law enforcement function. (For example positive management of injection vs. prohibition of pollution.)

4. Many new concepts and practices are required for adequate protection/safety systems, especially protection/safety systems related to antisocial technologies, increasing activity density, and multiplicity of use in common

water areas. These concepts will concentrate more on preventive methods, but reactive techniques will also be warrented in many new areas.

5. Organized and formal process for integrated sea use planning/ zoning will be mandated.

6. Development and operation of an effective unified surveillance, navigation and communication system will be ultimately enlisted.

7. The requirement for an analytical service capability will evolve in order to develop objective analyses and integrative assessments of resource development plans and institutional activity plans. Safety will be the organizing focus around which this will be built. The CG is a logical candidate for the assignment.

8. CG will persistently need to monitor emerging technologies that specifically relate to underwater operational systems in order to assure that evolving technologies are matched with current regulations and standards.

9. The changing character of offshore ports and vessels will require implementation of a number of environmental effect and safety studies.

RECOMMENDATIONS

1. A special agency-wide coordinated multiprogram underwater capabilities plan should be developed. This plan should be the sum of:

- Individual program plans specifically addressing the underwater capabilities and development needs for each of the current programs
- Additional "nonassigned" requirements not currently related to a specific program manager.

2. The above plan should be developed under the coordinative cognizance of an Underwater Activities Steering Group, appointed by the Commandant and reporting directly to him. Representation on the group should be as is necessary to assure adequate development of the plan, and monitoring of actual development and execution.

3. A special program of underwater R&D should be established, in order to integrate a systematic and sustained R&D program appropriate to the development of an effective underwater operations posture and capability within the CG.