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SAFETY AND OFFSHORE OIL: BACKGROUND PAPERS OF THE COMMITTEE ON --ETC(U)
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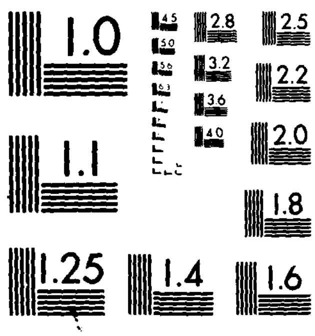

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Safety and Offshore Oil:

Background Papers of the Committee on Assessement of Safety of OCS Activities

Marine Board
Assembly of Engineering
National Research Council

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NATIONAL ACADEMY PRESS
Washington, D.C. 1981

401547

This document represents work supported by Contract Number 14-08-0001-18602 between the U.S. Geological Survey and the National Academy of Sciences.

Limited copies available from:
Marine Board
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PREFACE

In June 1979, the U.S. Geological Survey requested that the National Research Council undertake an examination of the adequacy of existing technologies and current regulations for safeguarding human health and the natural environment during oil and gas operations on the Outer Continental Shelf (OCS). Accordingly, the National Research Council convened the Committee on Assessment of Safety of Outer Continental Shelf Activities to conduct the investigation under the aegis of the Marine Board. The recently issued final report, Safety and Offshore Oil, presents the committee's findings and recommendations of the study.*

In the course of the committee's study, a number of papers were prepared by individuals and working groups to provide background analysis of the relevant issues and to describe related technological matters (see Appendix). Photocopies of these papers are available upon request to the Marine Board.

Some of the background papers are informed points of view while others consist of technical analysis not available elsewhere. It is recognized that some of the viewpoints presented may seem extreme and are not fully supported. The purpose of this volume is to make some of the papers available to interested readers of the committee's report and to others concerned with the subject.

Four types of papers are included here:

--Some Public Policy Considerations in Outer Continental Shelf Development and Regulation. The committee sought to gain an understanding of the public context in which OCS activities are undertaken. To this end, committee members wrote papers expositing public and industrial perspectives on OCS safety and the international regime for offshore safety.

--Aspects of the Offshore Oil and Gas Industry. Certain aspects of the offshore oil and gas industry that play a role in the safety of OCS activities were investigated. These include insurance of OCS operations, organization of oil spill cooperatives, training and quali- fication of OCS workers, and cost of industrial compliance with OCS safety regulations.

*National Research Council, Safety and Offshore Oil, Report of the Committee on Assessment of Safety of Outer Continental Shelf Activities, Marine Board, National Academy Press, Washington, D.C., 1981.

--Adequacy of Environmental Information. As the committee became aware of the lack of agreement concerning the adequacy of environmental data and information to support OCS regulations, it sought to document the diversity of views among scientists. Three marine scientists who have conducted research on the fate and effects of hydrocarbons in the marine environment were asked to evaluate the conflicting data and reports that are part of the scientific debate.

--Assessments of OCS Technologies and Systems. OCS activities incorporate a wide array of technologies and systems. Technical assessments of selected technologies and systems were prepared in order to facilitate the analysis of the adequacy of technologies and regulations to contribute to safe operations in the OCS.

Each paper is the work of an author or authors who accept full responsibility for its content. The authors are members of the committee or invited scientists and engineers with recognized competence in their fields. None of the papers has been critically reviewed in accordance with the procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. Some of the papers are based upon or taken from manuscripts prepared for publication elsewhere.

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ASSESSMENTS OF OCS TECHNOLOGIES AND SYSTEMS

A PUBLIC PERSPECTIVE ON ENSURING THE ADEQUACY OF OCS SAFETY

by

Sarah Chasis

The federal government is engaged in a program to annually lease millions of acres of the Outer Continental Shelf (OCS) for oil and gas exploration, development, and production. This paper discusses public concerns regarding the OCS leasing program and suggests ways to respond to those concerns and ensure environmental protection.[1]

1. Background

Federal leasing--the sale of extraction rights--of the Outer Continental Shelf (OCS) has been underway for over 25 years. Until 1973, an average of only 500,000 acres per year were leased. Following the Arab oil embargo of 1973, however, the President announced the goal of leasing 10 million acres per year of the OCS--as much acreage as had been leased over the entire previous 20 years. While this goal has been scaled down, the federal government's leasing program is presently proceeding at a greatly accelerated rate, with more than six million acres leased between 1974 and 1979. In June 1980, the Secretary of the Interior submitted to Congress a five-year leasing program for the period 1980-1985. It proposes 36 lease sales over the next five years with a total of more than 20 million acres potentially to be leased. Virtually every region of the OCS is included on the schedule.

Much of the accelerated leasing is occurring in frontier areas off the Alaska, California, and the Atlantic Coasts where there has been no previous experience with oil drilling. In many of these frontier areas, the environmental conditions are extremely severe and the renewable resources extremely valuable and fragile. For example, leasing is proposed in areas containing some of the greatest commercial fisheries in the world, as well as in areas that represent some of the most biologically productive areas in the world. Data to gauge the effects of drilling are unavailable, and technology not only to develop, produce and transport hydrocarbons but to contain and clean up spills does not exist.

2. Environmental Concerns

The adverse effects of this leasing program on valuable coastal and marine environments could be severe. To some extent, the magnitude of these impacts cannot be easily gauged at the present time. This is because little information exists concerning the effects of hydrocarbon extraction on the biological resources in these areas.[2]

While lack of critical information to properly assess environmental risks is one major source of public concern, other concerns relate to known risks associated with offshore development. Oil spills associated with drilling operations and the transport of oil ashore for processing and refining--whether by tanker or pipeline--can and do pose major threats to offshore fishery resources, coastal salt marshes, and beaches. The catastrophic spills that have occurred at the Ixtoc I and Ekofisk platforms in the Gulf of Mexico and in the North Sea, respectively, as well as the 1969 Santa Barbara spill, are examples of the major spills we potentially face off our coasts.[3] These types of catastrophic spills represent risks inherent in offshore drilling. The Interior Department predicts that there is a 40 percent chance of at least one large oil spill occurring on Georges Bank if drilling there proceeds. Paul "Red" Adair, the individual credited with stopping the North Sea blowout, testified before Congress that such spills will always occur wherever drilling exists, no matter how sophisticated the equipment used, because of the potential for human error.

Chronic, low-level oil spills also pose a significant threat to the environment. For example, oil must be brought to shore either by tankers, barges, or pipeline, and low-level discharges of oil into the environment are associated with each of these forms of transport. In the past, pipeline accidents released more oil to the marine environment than any other source directly related to OCS operations.

In addition to catastrophic and chronic oil spills, routine operational discharges from drilling and production operations are also a source of concern, particularly in sensitive marine areas such as coral reefs, fish and shellfish spawning and nursery areas, and bottom communities near drilling platforms. The operational discharges consist largely of drilling muds, drill cuttings, and formation waters containing suspended oil and brine. Studies on the fate and effects of these discharges have been found to be inconclusive, and there has been little agreement on the adequacy of the studies conducted. While these discharges are less dramatic than the catastrophic spills, the cumulative effects of such discharges over a 20-year period could pose a threat to certain marine environments.

Oil pollution can have serious impacts on both the offshore and nearshore environment. The reproductive potential of adult fish may be impaired. Eggs and larvae of marine species, particularly lobster, are highly sensitive to oil. A summer oil spill, affecting the breeding or young of many species, would cause the greatest harm and could seriously affect the long-term productivity of a fishery-rich area such as the Georges Bank. The Interior Department itself has admitted this in its Environmental Impact Statements on Lease Sale 42 and the Five-Year Program.

Environmental impacts of oil pollution can be particularly significant in nearshore areas. Oil contamination of a salt marsh can disrupt the food chain that depends on the marsh for productivity. Coastal bays and estuaries are also vulnerable. Petroleum may destroy eggs, larvae, and juveniles of many species which inhabit the estuary. Oil accumulated by filter-feeding shellfish may impair their reproduction and alter their physiology. Oil that enters bottom sediments may affect an ecosystem for years.

In addition to public concerns regarding oil spills and operational discharges, other potential impacts of concern relate to the onshore development associated with offshore activities. Environmental, land use, and socioeconomic disruptions may result from the size and speed of building an onshore development. Experience in Louisiana, where offshore development has existed for a long time, is instructive. More than 40 percent of the loss of approximately one square mile strip of the entire Louisiana coast over the last 20 years has been attributed to damage from oil and gas development. Much of this impact may result from support industries such as construction activities involving offshore platforms, pipelines, tanker terminals and refineries.

In northeastern Scotland, where offshore development has exploded, direct employement in oil-support activities grew from 2,665 to 11,275 during the short period between December 1973 and March 1974. Local efforts to plan for this growth were not successful. Shortages of housing, skilled labor, berths in harbors, and equipment resulted and adversely affected established industries.

If onshore facilities could be channeled into already industrialized areas with existing infrastructure to support the development, the onshore threats posed by offshore drilling could be substantially decreased.

3. Means of Responding to These Concerns and Promoting OCS Safety

In light of the relentless pressure for increased OCS exploration and development and because of the substantial concerns this development poses, concerned members of the public, including environmentalists, commercial fishermen, and state and local governments, have pressed through litigation, lobbying of Congress, and through participation in federal agency proceedings, for the promotion of offshore safety. For the most part, the objective has been to ensure safety by encouraging federal agencies to:

a. Avoid OCS leasing in those areas that contain important renewable resources which OCS development threatens to destroy or irreparably harm. If OCS development must proceed in such areas, to schedule sales there only as a matter of last resort;

b. Restrict drilling in areas and during seasons of the year when oil spill containment and clean-up technology is not available or workable;

c. Impose strict environmental standards on leasing operations, particularly in frontier areas, in order to limit the possibility of blowouts, chronic spills, and operational discharges; require use of best available and safest technologies in all operations, including transportation, which could lead to spills or routine discharges;

d. Establish marine discharge criteria to assure the protection of valuable marine areas, and place effluent limitations on the discharge of pollutants to assure compliance with these criteria;

e. Obtain more and better information on the likely effects of oil development on the environment <u>before</u> deciding where to lease and where to allow development;

f. Disclose detailed information on the nature, extent and location of offshore oil and gas resources and the likely location of onshore facilities on a timely basis to states and the public to permit proper planning for likely onshore development;

g. Direct OCS-related onshore development away from fragile, productive coastal areas either to inland sites or to already developed areas which can withstand further development.

Unfortunately, agencies to date have not been responsive to many of these recommended measures. For example, no OCS area has been excluded from present or future leasing for environmental reasons. Drilling has not been restricted in areas where the potential for clean-up is severely limited. The statutory requirement for use of best available and safest technologieshas not been fully implemented by the Secretary of the Interior. The Environmental Protection Agency has failed to regulate most OCS discharges. Problems still plague the environmental studies program.

Much of the recalcitrance can be traced to the Administration's fierce commitment to adhere to an accelerated OCS leasing schedule in frontier areas. This commitment appears to completely override concern for the cost to competing resources such as fisheries and other potential impacts on the environment. Concern for OCS safety cannot and should not be slighted. Adhering to the safety measures recommended above is essential if public concerns for safety are to be alleviated, environmental protection assured, and a balanced leasing program achieved.

NOTES

1. Worker safety, which is a critical OCS safety issue, is not addressed in this discussion.
2. For example, despite the fact that a substantial portion of the federal budget for ocean pollution research has been devoted to studying the effects of oil pollution on the marine environment, The Federal Plan for Ocean Pollution Research, Development, and Monitoring 1979-1983 (August, 1979) states that there is little understanding or study of the sublethal effects of oil on marine ecosystems. The plan goes on to identify the evaluation of such sublethal effects as one of high priority for future ocean pollution research.
3. The Ixtoc spill represents the largest known oil spill from any source in world history: 140 million gallons. Apart from the blowout itself, the inability to stop the flow of oil for nine months underscores the inadequacies of well control and oil spill containment and clean-up technologies.

Sarah Chasis is senior staff attorney with the Natural Resources Defense Council, Inc., New York, a public interest organization specializing in environmental protection. She is a member of the New York State Bar and is active in the legal/environmental aspects of offshore drilling. Ms. Chasis is a member of the Committee on Assessment of Safety of Outer Continental Shelf Activities.

AN INDUSTRY PERSPECTIVE ON THE REGULATION OF OIL AND GAS OPERATIONS ON THE OUTER CONTINENTAL SHELF

by

O. J. Shirley

An Industry Perspective on Regulation

Any attempt to describe a good regulatory process for a free, industrialized society is bound to stir debate, if for no other reason than recognizing that such a "model" may be somewhat idealized, considering the political and emotional environment in which regulations are developed. All the same, and despite theinfinite variables, trying to describe the elements of a model regulatory process can provide a useful yardstick or point of reference for those who accept the arguments presented, and who are routinely interested in trying to constructively assess the effect of regulation on an industry.

If it is accepted that the industrial elements of a society, like private citizenry, must be regulated for the benefit of society as a whole, then it can be reasonably argued that a desirable degree of regulation is one which avoids the extremes of too much or too little regulation, and protects the interest of society as a whole while causing the least constraint on industrial productivity. Further, if the object of a free society is to maintain a high degree of personal and industrial freedom, it follows that the regulatory regime in that society should be the minimum required to protect society as a whole. Or said another way, no regulation should exist unless that regulation serves to benefit some significant element of our society.

A number of key tenets can be used to determine whether a beneficial and useful regulation can be developed. Among these tenets are the following:

- The regulation should satisfy an identified need.
- The regulation should have a well defined objective and purpose.
- The actions demanded by regulation should be technically feasible.
- The benefits of a regulation should be predictable.
- Regulatory benefits should exceed regulatory costs.
- Regulatory compliance and enforcement procedures should be straightforward.

- Regulations should be performance oriented.
- Similar activities should be similarly regulated.
- Regulatory actions must maintain perspective with reality.
- Penalties should be commensurate with the nature of the regulatory infraction and should be directed toward the primary offender.

Finally, recognition must be given to the limitations in accomplishments to be obtained by the regulatory process.

Comparison of OCS Regulations to a Regulatory Model

In the preceding section of this paper, an effort was made to describe the tenets of a good, regulatory process. As previously stated, such a "model" may be somewhat ideal, but it does provide a basis of reference for those who agree with the arguments presented in the model. For this reason, a comparison of the OCS regulatory complex to the model seems useful and is discussed in this section on tenet by tenet basis.

In each case the tenet will be stated, followed by its basis. Then the OCS regulatory regime will be compared to the tenet.

TENET 1 - THE REGULATION SHOULD SATISFY AN IDENTIFIED NEED

Basis

The need for regulations should be based on one of three factors. First, a presumption by society that an activity is being conducted in a manner conflicting with the general goals of society; second, the perception by the industry conducting the activity that uniform guidelines are necessary to control the activity; or third, a need for administrative control by the governing agency to carry out the mandates of resulting legislation. In the absence of one of these three conditions, the need for regulations cannot be sustained.

Comparison

For the OCS it is clear that substantive regulatory effort is needed. The extracted resource belongs to the public. Thus, government must assure that an equitable share of the proceeds go to the public treasury and that the resource is efficiently recovered. Oil and gas activities must be conducted compatibly with other industrial and recreational activities on the oceans. Therefore, all such activities must be governed to reduce conflicts between interests competing for the same space. Attendant shore facilities supporting the offshore operations are expected to be subjected to the normal regulatory processes for similar commercial or industrial enterprises in that community. Both industry and societal concerns for protection of the environment and worker safety demand that these areas be addressed and regulated as appropriate.

The present regulatory system for OCS operations addresses all of the above concerns. Unfortunately, the manner of address of the concerns is random, subject to overlapping jurisdiction among agencies, and confusing.[1] Although the broad societal concerns are addressed in many fashions, the need for the individual elements of the regulation is difficult to discern. The result is a voluminous montage of requirements and mandates placed upon the industry which address only peripherally in many instances the concern for which they should be designed.

TENET 2 - THE REGULATION SHOULD HAVE A WELL DEFINED OBJECTIVE AND PURPOSE

Basis

Once the need for regulatory activity has been identified, careful consideration should be given to the objective and purpose of the regulation. A high degree of specificity of objective and purpose is necessary if the regulation is to succeed. Regulations written to achieve broad, poorly defined objectives will fail.

Comparison

Primary concerns of OCS oil and gas development which require regulation include: assuring a fair share of return to the public; preventing waste of public resource; minimizing conflicts with other users of the ocean; protection of the environment; and protection of the safety of offshore workers.

Although it is possible to deduce the general area of concern which the regulations address, a specific area of concern is seldom spelled out in the regulation. A multitude of regulations, for instance, have been imposed upon the industry for the purpose of "improvement of safety and prevention of pollution." Unfortunately, very little thought appears to have been given to how a particular requirement will accomplish one of these objectives. For example, the Failure Inventory Reporting System (FIRS) will require the offshore oil industry to maintain records on tens of thousands of safety devices that are in operation at this time. One may surmise that the purpose of these regulations is to improve the reliability of such safety devices; however, there is no evidence that (1) such safety devices have proved sufficiently unreliable to require additional effort, or (2) that the improvement and performance of such safety devices would substantively affect safety of offshore operations or reduce oil spills. Similarly, requirements in OCS Order No. 2 concerning the annulus portion of the blowout preventer (BOP) stack require that these elements be designed for significantly higher pressures that has been the industry practice. Again, while the purpose of the regulation may be deduced as an effort to improve well control during OCS operations, there is no evidence presented to indicate that the annulus portion of the blowout preventer stack has been a significant cause of well control failure, or that the requirements imposed upon this element will improve the performance of that blowout preventer. In fact, there is evidence to suggest that the change in design of this equipment may promote improper use of blowout preventers should drillers fail to recognize that other portions of the system have a lower pressure rating than the BOP.

Yet another example is the informational requirements imposed on Plans of Exploration and Plans of Development. One may infer that the information required in these plans would be useful to federal agencies and to state governments to inform them of the planned actions of the operator, and the potential impacts of that operation upon the adjacent shore areas. In many instances, however, particularly relating to the Plan of Exploration, much of the information required is of a speculative nature beyond the control or knowledge of the operator. Thus, it serves no useful purpose for either the federal agency or the adjacent coastal state.

TENET 3 - THE ACTIONS DEMANDED BY REGULATION SHOULD BE TECHNICALLY FEASIBLE

Basis

If the action demanded by a regulatory process if of a technical or mechanical nature, scientific and technical evidence must be assimilated and analyzed to determine "state of the art" for the activities to be regulated. Obtaining these facts will often necessitate going to the industry to be regulated to obtain factual current information. Regulations demanding performance beyond the known scientific capability, and prognosticated on future but yet unknown improvements in the science, will be strongly resisted by industry, will likely result in excessive costs, and will be unpredictable in terms of benefits to be derived.

Comparison

To this juncture, most of the equipment requirements imposed upon the industry have been technically feasible although the value of many such requirements is highly questionable. A notable exception to this rule is the requirment to use Best Available and Safest Technology (BAST) as mandated by Section 21(b) of the OCS Lands Act Amendments. The initial difficulty with BAST is that it cannot be defined except in conceptual terms. Because of this difficulty, the revised OCS orders issued on January 1, 1980 arbitrarily defined BAST as being in compliance with the orders then in existence. While this seems a satisfactory solution to an otherwise insoluble problem, it illustrates the difficulty of imposing an ill-defined concept as a regulatory device.

Perhaps the most difficult conditions imposed by regulations and administrative action relates to the scheduling of activities on Plans of Development and to a lesser extent Plans of Exploration. When the Plan of Development is prepared by the operator, many uncertainties exist as to the exact nature of the reserves being developed. Information on the geology of the prospect is limited to that necessary for the operator to be reasonably assured that commercially exploitable reserves exist. The operator that prepares a program for development that extends two or perhaps three years into the future, knowing with certainty that the information on which the plan is based is in error, and that information obtained from wells drilled in the development program will make it highly desirable to change the Plan of Development. Changes in the Plan of Development based on better information will assure better recovery of the hydrocarbon resource for the operator and the nation, and will minimize unnecessary drilling. Despite these obvious difficulties and the likelihood that one or more wells in a development program may encounter delaying mechanical problems, there is a strong tendency to administer the plan of development with great rigidity. Thus, an operator is pressured to meet a development goal very near a target specified two or three years in advance which was based on a paucity of needed information; and which will likely result in less efficient development of the resource.

Other examples of technically unfeasible requirements include the imposition of the final OCS orders published on December 21, 1979, to become effective on January 1, 1980. Certain equipment changes were mandated by the new OCS orders. The interim between publication of the final orders and the effective date was insufficient for the operators to obtain compliance. Operators were faced with a choice of suspending all operations until obtaining compliance with the new OCS orders or assuming the liability of exposure to civil and criminal penalties for willful and knowing violation of the regulations. Further, some provisions of these orders had not been previously subjected to comment by the industry. A more recent and flagrant example of a technically infeasible requirement is the demand by the USGS that oil spill clean up equipment provided for Georges Bank exploration be capable of skimming in 8 to 10 foot seas and 20 knot winds. None of today's equipment has been proved to have this capability.

TENET 4 - THE BENEFITS OF A REGULATION SHOULD BE PREDICTABLE

Basis

If the purposes and objectives of a regulatory activity are known, the regulations designed to achieve these objectives should have benefits which are predictable. If the benefits cannot be quantified, it is unlikely that the purposes and objectives of the regulation will be satisfied. Regulations without quantifiable benefits will add additional burden of red tape and confusion and will serve no value either to society or to the industry.

Comparison

In the total array of regulations affecting OCS operation, there has been no formal effort to determine the benefit to be derived from an imposed regulatory requirement. Supposed benefits have been couched in high sounding phrases included in the OCS Lands Act Amendments, such as "...establish policies and procedures...intended to result in expedited exploration and development...to achieve national economic and energy policy goals, assure national security, reduce dependence on foreign sources,..." or in another example, "encourage development of new and improved technology for energy resource production ...eliminate or minimize risk of damage to the human, marine, and coastal environments." No effort has been made to illustrate or quantify how the individual elements of a regulatory action will attain the generic benefit. For example, in the area of reduction of oil spills, data show that the amount of oil spilled from OCS operations in U.S. waters accounts for approximately .3 of 1 percent oil spilled into the marine environment. The societal benefit of regulations designed to reduce oil spills in the OCS, if any, would have a maximum possible benefit were regulations 100 percent successful in removing this relatively small quantity of oil from the marine environment. No government studies have been made as to the actual benefits that would be obtained by society if all of the oil spilled by OCS operations were to be prevented from entering the marine environment. In short, what benefit is obtained by preventing one barrel or a thousand barrels of oil from entering the marine environment?

In addition to a lack of effort to obtain information on the overall benefits from a regulatory activity, there has been no effort to study the incremental benefits to be obtained from individual regulatory requirements. For example, if one assumes that allowing oil to enter the marine environment is inherently "bad," how much oil will be prevented from entering the environment as a result of a particular regulatory requirement? A prime example of lack of benefit analysis is the Failure Inventory Reporting System (FIRS). A rational approach to regulations would suggest that prior to imposing a system requiring extensive industry effort such as FIRS, the regulator would have knowledge (1) that failure of the safety devices subject to this regulation are a significant cause of oil pollution, (2) that the regulatory requirement will significantly improve the operation of these devices, and (3) that the net effect of the regulation will be to prevent some predictable quantity of oil from entering the marine environment. Such studies have not been made. Thus there is no predictable benefit from the imposition FIRS. In the absence of such studies, a spate of requirements are thrust upon the operating industry based on the view that this requirement may have a beneficial effect.

TENET 5 - REGULATORY BENEFITS SHOULD EXCEED REGULATORY COSTS

Basis

The societal costs of regulations include many factors, the cost to industry, the cost of government for enforcement of the regulation, the cost to society that the regulation may impose on price and availability of product, and the incremental impairment in industrial productivity which attends most regulatory action. Such costs are difficult to measure. Because of this difficulty, societal costs are frequently given little or only superficial attention in developing a new regulation. Despite these difficulties, an honest and thorough effort to assess the relationship between costs and benefits must be made. In the absence of this necessary analysis, incremental regulatory costs without accompanying benefits will be accumulated into a regulatory system in which costs to society far outweigh the benefits to be derived.

Comparison

As in the case of benefits, no effort has been made by government to determine the cost of regulations.

A current example of a regulation officially stated to have "no significant economic impact" is OCS Order No. 1, proposed paragraph 5, concerning "marking of equipment." Despite vigorous protestations by the industry as to cost and feasibility, this section provides that all equipment utilized or transported offshore be marked as to ownership irrespective of size or weight. As the regulation is written, knives and forks from the galley, hand tools, pencils, etc., will require marking in addition to short fragments of pipe or metal scraps from cutting and welding operations. Some employees would thus be involved full time in locating and marking such equipment at an exorbitant cost to the company. This approach to marking of equipment is ludicrous when one considers that the original objective of the regulation was to provide identification of materials of sufficient weight and size to hang or damage commercial fishing gear. An industry survey among seven major companies operating in the OCS shows that 26 percent of their total OCS manpower is devoted to regulatory compliance.[2] This equates to a cost of approximately $155,000,000 per year for the offshore industry in personnel costs alone, irrespective of capital and operating costs incurred by regulatory compliance. This degree of manpower drain is obviously excessive and is the outgrowth of government's failure to make an objective appraisal of the incremental cost of each new regulatory requirement governing the offshore oil and gas industry.

TENET 6 - REGULATORY COMPLIANCE AND ENFORCEMENT PROCEDURES SHOULD BE STRAIGHTFORWARD

Basis

Regulations imposed upon an industrial activity require or prohibit certain actions by company employees, often those working at the operating level. Actions required of these personnel should be clearly set forth if the management of the affected industry is to successfully translate the regulatory requirement to those who must effect compliance. Subjective requirements requiring further judgment by the managements of the industry or by operating personnel may be interpreted differently, which leads to conflicts and unnecessary tensions between the enforcement agency and the industry. Specific, well defined, requirements ease the regulatory burden of both the regulated industry and the enforcement agency.

Comparison

Most regulations dealing with the mechanical operations of OCS development activities are relatively straightforward. Rigid specifications have been set as to the mechanical operation of certain safety devices, the frequency that such devices must be checked and the margin of error to be allowed in their operation. Conversely, regulations and procedures relating to permitting activities, development and management of the resource, product price, informational requirements for POE's and POD's and CZM consistency certification, are highly subjective and variable. Examples of this subjectivity and variability are discussed below.

NPDES Permits (EPA)

Despite the fact that discharges emanating from drilling and producing operations in the OCS are relatively uniform and have not changed substantively in over the past 30 years, requirements for obtaining NPDES permits vary radically among the various EPA regions. Results to be expected from filing an application for NPDES permits in the OCS are totally unpredictable. The processing time, information requirements and ancillary effort (e.g., monitoring flow programs, special studies, etc.) - are subject to the whims of the administrator and staff of each region. Additional variability is added by the entity to which the permit is granted. For example, Region IX (West Coast) issues NPDES permits to drilling rigs while Regions in the Gulf and East Coast issue NPDES permits to leases. Extensive research on the nature and effects of discharges from OCS drilling and producing operations has been largely ignored by EPA headquarters and each EPA Region has been allowed to "reinvent the wheel" for activities within their jurisdiction. The lack of a uniform national standard for effluent discharges in the OCS and the lack of uniform procedures for administering the NPDES permit have been the source of great frustration to the oil industry and has caused unnecessary delays in vital exploration work. The lack of predictability as to <u>when</u> a NPDES permit will be issued and the conditions to be imposed by the permit cause great difficulty in obtaining and scheduling drilling rigs for exploratory work.

<u>Permitting Difficulties OCS Sale No. 42</u>

Other difficulties with permits are well illustrated by the current situation regarding OCS Sale No. 42 on Georges Bank which was held on December 19, 1979. As of late May 1980, obtaining permits for exploratory drilling involved the following:

Plan of Exploration (POE)

The POE must provide an oil spill contingency plan. Approval of the plan is within the authority of the USGS. The responsibility for approving contingency plans for Georges Bank has been delegated by the USGS to the U.S. Coast Guard. Industry representatives (Clean Atlantic Associates (CAA)) have met twice with the U.S. Coast Guard to discuss contingency plans, but at this writing guidelines are unavailable, which has delayed any purchase of new equipment that may be mandated by the guidelines. (It is interesting to note that the stockpile of oil spill clean-up equipment obtained by CAA for Georges Bank was previously approved by the USGS but the approval was subsequently rescinded with the delegation of responsibility for contingency planning to the U.S. Coast Guard.)

By agreement among DOI, EPA, and NOAA, a Biological Task Force (BTF) was established to address environmental issues arising from OCS drilling and development on the Georges Bank. The BTF is charged with identifying areas of special biological sensitivity and addressing alternate methods for disposal of drilling mud and cuttings. Both issues must be covered by the operator in the POE. At this writing no definite action has been taken on either subject.

NPDES Permit Applications

NPDES permit applications must address Section 403(c) issues of the Clean Water Act of 1972, as amended (Ocean Discharge Criteria). Regulations governing Ocean Discharge Criteria are in effect as of August 1980.

The NPDES permit must also address the discharge of drilling mud and cuttings. Should such discharge be prohibited by actions of the Biological Task Force or by legislation, alternate disposal sites off the New England Coast must be considered as Massachusetts is prohibited by law from accepting wastes considered to be toxic. EPA has taken no action to establish alternative ocean dump sites. It is estimated that a minimum of 15 months would be required to establish a new ocean dumping site and to obtain a permit to dump at that site. There is no certainty that either ocean or land dump sites can be obtained.

The above discussion is limited to but a few of the difficulties facing the oil industry in attempting to obtain permits to explore leases obtained in one lease sale--OCS Sale No. 42. Most of these difficulties arise because of inaction by one or more federal agencies. A further difficulty will be experienced in obtaining "consistency certification" from the affected coastal states. Of four "affected" states with approved CZM plans only Massachusetts has informed operators of its data requirements for consistency review. These requirements appear unnecessarily complicated and time-consuming (it is estimated that 180 days will be required to certify consistency) in view of the fact that Massachusetts will be impacted only minimally by the exploratory operation on Georges Bank.

The point is that most, if not all, of the subjective and arbitrary decisions concerning OCS development could be eliminated by the establishment of consistent policies and procedures by those agencies regulating the OCS.

Other Regulatory Uncertainties

The foregoing discussions should adequately inform the reader of difficulties relating to obtaining permits for OCS activities. Without belaboring this subject further, let it suffice to say that equal difficulties resulting from subjective judgments or inaction by agencies involved in regulating the OCS, arise relative to pricing of natural gas and crude oil production, the formation of exploration and production units, change in plans of exploration or Plans of Development--and a large number of other operating and business decisions relating to OCS activities.

TENET 7 - REGULATIONS SHOULD BE PERFORMANCE ORIENTED

Basis

Regulations should be structured in a manner that will allow the industry to participate in achieving the desired objective. Regulations designed to obtain certain performance goals enable the industry to use the initiative and innovative ability of its personnel to obtain a goal. A regulation that is structured to require the industry to follow specific procedures or to install specific equipment is likely to become obsolete and unnecessarily burdensome, preventing utilization of new techniques or innovations which would achieve the desired goal in a more efficient, less costly manner.

Comparison

The vast bulk of regulations governing OCS activities are directed toward what-to-do, how-to-do, and when-to-do, and what equipment should be installed rather than toward results to be obtained. In concept, the NPDES permit procedure is an exception to this statement as it customarily specifies the effluent quality without specifying the manner in which the effluent quality is to be achieved. Unfortunately, in the OCS the normal mode of issuance of NPDES permits has not been achieved and NPDES permits have been heavily burdened with what-to-do, how-to-do, and when-to-do requirements. Of the limited number of NPDES permits granted for OCS operations, most have been the subject of intensive discussion and debate with the agency to determine guidelines to be followed, and have entailed stipulations requiring the industry to perform detailed monitoring program, bioassays, and other field and laboratory work. Until recently EPA Region IX (West Coast) has been the single exception to this rule and have granted permits to drilling rigs on a semi-routine basis. This practice was recently suspended to hold an evidentiary hearing concerning the discharge of drilling mud and cuttings from wells to be drilled on tracts leased in OCS Sale No. 48. Unless operators agree to barge drilling mud and cuttings, it is now anticipated that all drilling operations will be suspended for a period of at least nine months while the evidentiary hearing progresses. Interestingly, discharge of mud and cuttings was routinely permitted from wells drilled on adjacent tracts leased in prior sales.

Beyond the ultimate hope that NPDES permits may one day become performance oriented as intended, a study of the OCS orders shows isolated examples of the application of objective performance requirements. For example, OCS Order No. 5, paragraph 8, which requires the lessee to have a program to eliminate accidents due to human error. Also, paragraph 7, requires the lessee to purchase, maintain and operate cranes in accordance with the practices set out by API. No other regulations exist which allow the operator to use his innovative skill to obtain the desired goal. The net result is that operating supervisors and personnel spend much time complying with the "letter of the regulations," which detracts from the time available to plan the safe execution of work. Further, the existing detailed regulations requiring specific actions inhibit innovations to develop better, more efficient approaches to obtain an overall regulatory requirement.

An example of an alternative to the existing detailed regulations designed to prevent oil spills would be to (a) require that all operators have systems designed to prevent and contain oil spills, (b) require reporting of all oil spills and (c) assess heavy fines upon operators when significant oil spillage occurs. This procedure would enable each operator to choose equipment to develop operating procedures and training programs to his liking, and to preferentially benefit from the results of his effort. Operators with poor performance records would suffer the consequence of their poor operation. Enforcement agencies could then concentrate on problem areas rather than attempting to provide equal inspection attention to both well-managed and poorly-managed operations. Similar techniques could be employed for drilling rigs in the area of blowout prevention or for other operational concerns now subject to regulation.

TENET 8 - SIMILAR ACTIVITIES SHOULD BE SIMILARLY REGULATED

Basis

If two or more industrial activities give rise to the same societal concern, the regulations governing these activities within the different industries should be similar. Actions taken to correct an undesirable social consequence of an activity should be relatively nondiscriminatory between industries if competitive balances are to be maintained. The action taken should relate to the social goal to be achieved with an even-handed approach to all activities which affect the achieve ment of that goal. Onerous and stringent regulatory requirements should not be imposed on one industry while activities causing similar effects are relatively unfettered in another industrial or societal activity. Consideration of equitable regulatory regimes between similar activities should, of course, include consideration of applicable technologies, and the cost-benefit ratios resulting from the regulatory activity.

Comparison

There has been a great tendency to regulate the Outer Continental Shelf drilling and production activities in isolation from other industrial and recreational activities that occur on the Outer Continental Shelf. Environmental concerns raised concerning OCS activities include the discharge of drilling mud and cuttings, the discharge of produced water, oil spills, sewage effluence, and the impact of power source emissions and drilling and production operations upon the air quality of adjacent states. Concerns have also been expressed about the "chronic" effect of these discharges upon the marine ecosystem. Paradoxically, the discharge from outboard motors which operate in the OCS and in more sensitive estuarine and bay areas is exempt from regulation despite the fact that EPA studies show an annual discharge from outboard motors ranging from 220,000 to 670,000 barrels of oil. Sewage outfalls from fishing camps and, until recently, pleasure vessels were exempt from regulation, or such regulations were poorly enforced. No consideration has been given to regulating emissions from diesel engines of thousands of fishing vessels on the OCS which could be a source of chronic water pollution as well as air pollution, and which collectively have a combined horsepower rating exceeding by several orders of magnitude the power plants used in OCS operations.

A casual observer in an aircraft overflying a fishing operation will notice a heavy plume of sediment behind the vessel as the trawl boards scrape the ocean bottom. No regulatory concern has been directed at fishing activity which disturbs and redistributes annually vast quantities of sediment many times greater than the sediment placed into offshore waters by OCS drilling operations and pipeline activities. Rough estimates suggest that otter trawling operations on Georges Bank alone disturb and redistribute about 8 billion cubic yards of sediment annually compared to approximately 1000 cubic yards of solids generated by drilling an exploratory well. If the sediment redistribution by the fishing industry is considered to be socially acceptable, why are stringent regulations needed to control the infinitesimally small volume of sediments derived from drilling and pipeline laying operations? In a similar vein, what is the value of requiring the oil industry to run archaeological surveys on Georges Bank when the ocean bottom has been scraped for approximately two centuries by the heavy trawls and clamming rakes utilized by the fishing industry?

TENET 9 - REGULATORY ACTIONS MUST MAINTAIN PERSPECTIVE WITH REALITY

Basis

There is a growing tendency to develop regulations of an industry in isolation of the natural environment and societal activities already in place, which may in themselves produce effects equal to or greater than the activity being subjected to regulation. This tendency is particularly evident in the environmental regulations. Perspective must be maintained on the totality of the problem being addressed by regulatory action. It is unreasonable and nonproductive to impose severe and onerous regulatory restrictions on an activity that contributes a small increment to the total problem when the larger problem may be beyond technological or regulatory control. Regulations imposed to gain insignificant incremental change in a larger uncontrollable impact, provide no benefit to society and impose nonproductive work and expenditures upon the regulated industry.

Comparison

Despite the high standard set for industrial activities by EPA and environmentally conscious citizens, the world remains imperfect. Nature herself fails to comply with many of the stringent standards that are judged by man to be desirable to protect the environment. Oil continues to naturally seep into the oceans in many localities throughout the world. Despite great debate over the disposition of dredged materials originating from man's activities, the rivers of the world continue to build deltas into the ocean areas comprised of sediments derived from vast areas of the continents. Fresh water runoff during flood stages of rivers dilutes the salinity of sensitive bay and estuarine areas, thus devastating larval stages of shrimp and fish and causing temporary reductions in catches of these species. Trees emit photochemical oxidants into the atmosphere, causing heavy smog in certain areas of the continents.

In a similar vein, nature does not cooperate with those who wish to establish a risk-free habitat, despite the efforts of well-meaning groups who sincerely desire that all industrial activities be free of risk to workers and the public. Nature continues to reek havoc with the populace of the world through floods, earthquakes, hurricanes, fires and other events causing great devastation.

Further, the activities of the society entail certain risks to the members of the society, as all of man's activities are imperfect and fraught with uncertainties. Vast numbers of people are killed and injured in automobile accidents and other transportation-related accidents in the United States each year. People are killed or seriously injured in accidents at home or in recreational activities.

Regulatory action should take cognizance of the situation that exists in the real world surrounding us, and utilize a pragmatic approach toward regulating man's activities. For example, consider the issue relative to long-term effects of crude oil in the marine environment. Coal Oil Point is a natural oil seep occurring approximately five miles offshore from Santa Barbara, California. This seep is known to have existed throughout the earliest recorded history of California, and has likely existed for eons. Extensive studies have shown the ecosystem surrounding this natural seep to be normal and healthy. Similar studies around other natural seeps in the world have been made with similar results. These facts should be pragmatic evidence that there are no significant detrimental long-term effects from oil in the marine environment. This view is strengthened by the fact that all of the oceans of the world contain bacteria capable of assimilating and breaking down crude oil. The existence of these bacteria throughout the natural environment and their dependency upon oil as a nutrient suggest that oil is a natural part of the marine environment. Acceptance of this fact leads one to conclude that nature has accepted crude oil as a natural part of the marine ecosystem. Thus, searching for long-term effects would appear fruitless.

Other interesting comparisons may be made relative to oil spill incidents in U.S. waters. Based on U.S. Coast Guard statistics approximately 375,000 barrels of oil are spilled annually in the waters of the U.S. Of this total spillage, approximately 1,150 barrels are derived from OCS drilling and production operations. The remaining volume is attributed to transportation, storage and use of the crude oil or refined products.

During 1979, approximately six billion barrels of crude oil were consumed in the United States. Spillage of 375,000 barrels amounts to 62 barrels of oil spilled for each one million barrels of oil consumed. Data previously presented show that approximately 3.3 barrels of oil are spilled for each million barrels of oil produced in the OCS. This spillage rate approximates 1/20 of that occurring during transportation and consumption. From this real world perspective, one must again question the value of the intensive regulatory effort on OCS operations, particularly in light of the fact that the quantity of oil spilled by OCS operations is insignificant relative to the total volume of oil spilled, and the performance of the offshore industry is substantially better than that of the society in which it operates.

Another topic under intensive debate concerning OCS operations is the discharge of drilling mud and cuttings into the marine environment. Despite intensive laboratory research and field monitoring tests which show the effects of drilling mud and cuttings to be relatively benign, controversy remains as to the toxic effects of chemicals contained in the mud, and the effect of sediment derived from mud and cuttings which are to be deposited upon the ocean floor. In the real world, the Mississippi River alone deposits millions of pounds of sediments in the Gulf of Mexico each day, which is equivalent to the amount of sediments generated by thousands of wells. Mississippi River effluent contains chemicals in runoff from agricultural lands approximating two-thirds of the continent, in addition to those derived from manufacturing plants located adjacent to the river. By contrast chemicals normally found in drilling are of relatively low toxicity and monitoring tests have shown all effects from drilling mud are reduced by dispersion to an undetectable level within 100 meters of the point of discharge.

Other interesting comparisons to the effects of drilling muds are those that may be derived from the fishing industry. It is interesting to note that fishing activity on the Georges Bank disturbs and redistributes sediments in one day equivalent to drilling thirty-two 10,000-foot wells. Similar sediment disruption and redistribution is caused by all trawling operations conducted around the periphery of the United States on the OCS with total sediment disruption and redistribution each many thousands of times greater than that caused by the offshore oil industry. If the societal concern is the disruption of benthic communities on the ocean floor, one must ask why the total devastation of these communities by the heavy trawl boards and clamming operations of the fishing industry is a societally acceptable activity, when the discharge of a tiny fraction of sediments from OCS drilling activities is unacceptable.

One final comment on pragmatism. There are those in our society who stand on the premise that no activity should be allowed until all facts are known. This premise has been used repeatedly regarding operations in the Outer Continental Shelf. When the preponderance of evidence indicates that no harm can be readily detected from an activity, critics back off to a position that further studies are needed to determine long-term impacts that may not be readily discernible from early research work. The truth is that mankind will never know all there is to know about the oceans and the marine environment. If we are to survive, and make reasonable use of the resources available to us, we must make practical decisions based on information reasonably obtainable. Activities causing demonstratable detrimental effects on the environment must be modified to overcome those impacts. Activities causing no significant detrimental effect on the environment must be allowed to proceed, leaving future generations with greater knowledge and better tools, to correct the errors made by this society.

TENET 10 - PENALTIES SHOULD BE COMMENSURATE WITH THE NATURE OF THE REGULATORY INFRACTION AND SHOULD BE DIRECTED TOWARD THE PRIMARY OFFENDER

Basis

The mode and measure of criminal punishment is based on the principle of equity, with the symbolic side of justice assuring that the punishment will be balanced against the offense to the public. Posed as a simple question--does the punishment fit the crime?

Comparison

There is a growing tendency in legislation and regulation to make the chairman of the board or the chief executive officer of a corporation accountable for the actions of all employees of that corporation. There is also a growing tendency to extract criminal as well as civil penalties against top management of major corporations.

Penalty provisions for the OCS industry are severe and provide both civil and criminal remedies for any violation or false information, however minor, which can be construed to be knowing or willful. Public Law 95-372 of September 18, 1978, states that "any person who knowingly and willfully (1) violates any provision of this Act...shall, upon conviction, be punished by a fine of not more than $100,000 or by imprisonment of not more than ten year or both."

The establishment of such penalty provisions can cause great trauma within a corporation. Signatory requirements for many permits place company executives in the position of attesting to information prepared by multiple subordinate organization levels beyond the executives' direct control or knowledge. A case in point is the requirement for a vice-president's signature on NPDES permits. On occasions regulations have been made effective immediately upon publication, placing the industry in "knowing and willful" non-compliance, and forcing company executives to choose between exposure to criminal liability and suspension of all OCS operations. The previously cited example of OCS orders issued January 21, 1979 becoming effective January 1, 1980 illustrates the point. In other instances, through agency inaction or inability, mandated permits have not been issued for several years forcing again the choice between continuing to operate under questionable permitting authority, and total suspension of OCS operations for an indefinite period. This situation exists in EPA Region IV (South Atlantic) with respect to all NPDES permits for OCS operations.

A scholar of the law has pointed out that punishment is misapplied when it is superfluous to the act. In today's society many infractions of existing regulatory requirements carrying criminal liabilities cause no harm to society. Many regulatory requirements carrying such liabilities are enacted to provide an enforcement agency with a large stick to obtain compliance with regulations of sometimes questionable value. The proponents of such severe penalties may argue that criminal penalties can only be imposed if the infraction is "knowing and willful." Given the adversarial relationships that prevail in our society, such provisions provide little solace to the company executive.

Detailed Examples of Recent Regulatory Changes

Most oil industry observers who now complain strongly of the current regulatory excess would likely agree, paradoxically, that additional regulation of OCS activities was needed at the time of the Santa Barbara incident in 1969. Government actions and regulatory changes were needed following Santa Barbara and two less spectacular incidents in the Gulf of Mexico. Responsible companies viewed the upgrading of safety regulations with favor in that all companies were thereafter required to operate to an acceptable standard of safety and environmental concern. This more or less optimum level of regulation was attained in the 1971-1974 era. Unfortunately, once begun, the momentum toward regulatory change did not lessen with this attainment and has mushroomed with the passage of the OCS Lands Act Amendments of 1978. The more recent regulatory changes have been burdensome and nonproductive. Examples of these changes are discussed below.

Regulations on Exploration, Development, and Production Plans (30 CFR 250.34)

Promulgated in 1954 to require lease operators to file exploration and development plans, the history of this regulation in the 1970's, particularly after 1975, is one of confusion created by the Department of Interior (DOI). The regulation has been revised and reissued to the point where, despite industry objections, inflated and sometimes abortive prerequisites to obtaining clearance to proceed with exploration and development have in no way aided efforts to increase the oil and gas supplies of this nation.

A vast expansion of the regulation was proposed by DOI in September 1977 to which the industry vigorously objected. Mature areas in the Gulf of Mexico, which had been undergoing drilling and development for over 25 years, and which at the end of 1977 had a productive potential of some 897,000 barrels of oil per day from 3,066 wells, in addition to 12 billion cubic feet of gas per day from 2,174 wells, were to be administered the same as unexplored frontier areas. For example, before a new plan to drill one more well on any lease would be approved, an Environmental Report on the lease would be required.

The proposed September 1977 expansion of the regulation was again revised and made effective January 1978, to apply to North Atlantic Lease Sale No. 42 (which was postponed) as well as to the entire OCS. The industry again vigorously objected. In March 1978, the Secretary of Interior replied to the objections to the January versions of the regulation in a letter to the President of the American Petroleum Institute. He granted a temporary postponement of the new rules in some cases, but refused to eliminate the basic objectional requirements, although admitting that "...some delay in exploration and development is inherent in the regulations." The Secretary justified the regulations for the "purpose of providing affected states with needed information to avoid future controversies." Yet in the mature portions of the Gulf of Mexico, where the explosion of Federal regulations has fallen most heavily on the industry since 1975, the states' requirements are very modest. Louisiana and Texas are the most severely impacted states, and yet the regulations by which they control drilling operations in their own onshore and offshore areas have changed little in 25 years. On March 8, 1978, March 29, 1978, August 8, 1978, and November 1, 1978, the Department of the Interior backed away from some of the provisions of the regulation, first because of pressure from the industry and later because of lack of authority from Congress (Outer Continental Shelf Lands Act Amendments). The regulation was yet again revised and reissued September 14, 1979, effective December 13, 1979.

A comparison of the impacts of early and late versions of the regulations is revealing. A typical exploration plan in 1971 consisted of three pages of text and maps prepared in 4 man-hours, and often was approved by the United States Geological Survey 10 to 30 days after receipt. A 1971 development plan involved about the same effort. By comparison, the January 1978 exploration plan required up to 39 copies of about 50 pages per copy, and a development plan required up to 25 copies of about 90 pages. Such a plan format was required even in the mature portions of the Gulf of Mexico, and the man-hours required for preparation rose to over 100. Even after the DOI had modified some of its early 1978 requirements, a 1979 plan of exploration in the Western Gulf of Mexico would typically require about 20 man-hours for 9 to 17 copies of a 16-page submittal. A typical development plan would require about 32 man-hours to prepare 9 to 17 copies of about 20 pages each.

Efforts by one major company (Shell) to maintain or increase production rates over the same comparative period of 9 years in the Gulf of Mexico OCS are evidenced by the continued high level of drilling, the number of approved plans being executed, and the purchase of over 160 leases. During 1971, Shell produced about 62 million barrels of oil and 241 billion cubic feet of gas and drilled about 86 development wells and 28 exploratory wells under some 15 approved development and exploration plans. In 1979, the company produced about 41 million barrels of oil and 370 billion cubic feet of gas and drilled about 97 development wells and 14 exploratory wells under 30 plans. The modest differences between these statistics reflect the increased difficulties in finding oil and gas and bringing it to the market. The regulatory burden to obtain clearances for exploration and development plans only adds to the already increased scientific, operational, and financial burdens.

Furthermore, many of the details required to be submitted after January 1978 in an exploration or development plan for an OCS lease in the mature portions of the Gulf of Mexico are of questionable value to the DOI and should not be required. The details reflect the operator's data newly prepared to aid in reaching a decision to drill, or on hand from previous projects. These data are frequently of critical importance to the operator, and illustrate his intentions. DOI sends these data, in part, on to the affected states.

Yet this information, to our knowledge, is not used for any decisions by the states or by the DOI except that the plan is complete or incomplete.

Finally, it's worth emphasizing that, although the DOI may reiterate its policy that a plan must identify and provide for the exploration of all potential hydrocarbon accumulations, and that the USGS must inspect plans accordingly, an experienced operator has pointed out that this policy is impractical, considering that new prospects remain to be discovered and explored on some leases decades after initial development.

Regulation of Suspensions of Production, Operations, or Both (30 CFR 250.12)

The complexity of OCS operations could be alleviated by simplifying the rules for administering the suspension of an OCS type dictated by the inflexibility of the DOI's schedules. Three of the applications were later withdrawn by Shell because drilling or production progress in the field outsped the lead time allotted to accommodate the Secretary's cumbersome application and approval procedures. In the event, the Secretary approved all the suspension applications. In all cases they are justified (a) by a situation where two leases were being served by the same structure and facilities, and drilling or producing operations on one lease would interfere with operations on the adjacent lease, or (b) by the need for new facilities to serve newly drilled wells. The alternative would have been to conduct dangerous operations and/or risk the loss of the leasehold and the temporary or permanent loss of wells, structures, facilities, and production to the operator and the nation.

Finally, the Secretary's rules are an unnecessarily complex method of requesting and granting OCS lease suspensions. A return to the pre-1977 method of requesting and granting would work well in terms of time and encouragement of thorough development drilling and increased production potential.

OCS Order 5.6 - Failure and Inventory Reporting System (FIRS)

The USGS has established the Failure and Inventory Reporting System (FIRS) for the stated purpose of "enhancing the reliability and safety of operations in the OCS." The USGS is to identify potential problem areas, rather than having to experience expensive and dangerous series of replacements.

As mentioned in an earlier section of this report, a multitude of regulations has been imposed upon the industry for the purpose of "improvement and safety and prevention of pollution." Unfortunately, very little thought appears to have been given to how a particular requirement will accomplish one of these objectives. FIRS is a prime example. It will require the offshore oil industry to maintain records on tens of thousands of safety devices including 19 types of safety and pollution prevention devices (e.g., check valves, relief, temperature sensors, etc.) in operation in the OCS at this time. Records will have to be updated monthly and verified semiannually. The initial inventory costs will be approximately $2,500 per platform, and updates will cost a minimum of $1,000 per year per platform. It is estimated that a minimum of $5 million will be required to inventory the Gulf of Mexico platforms. The industry will be required to report failures of devices and the cause for the failure. The USGS will prepare a printout of the failures by manufacturers, model and cause, and update their inventory of the operator's replacement equipment. The agency will furnish each manufacturer with a copy of reported failures of that firm's devices.

One may surmise from all of the details that the purpose of these regulations is to improve the reliability of such devices; however, there is no evidence (1) that such safety devices have proved sufficiently unreliable to require additional effort, or (2) that the improvement and performance of such safety devices would substantively affect safety of offshore operations or reduce oil spills.

Members of the industry doubt that the data supplied from the program will yield any information on design weakness of failed devices. Device manufacturers should already be aware of failures. Potential design weakness and probability of failure information could be obtained at considerably less cost by manufacturer-conducted laboratory bench tests.

Finally, we would observe that because the FIRS program is a mandatory part of an OCS order, the collection and analysis of data will continue indefinitely, regardless of the cost-related effectiveness of proven benefits, if any. The FIRS program is a classic example of data collecting for anticipated result in a regime which is not applicable for the many faceted OCS operation.

Cumulative Results of OCS Legislative and Regulatory Actions

The offshore oil and gas industry is now governed by voluminous regulations from multiple agencies with overlapping jurisdictions. The regulatory network covers activities from "conception to grave," is time consuming and costly to both industry and government and is producing results of questionable benefit. Many regulations tend to be oriented toward technology (how to do and what to do) rather than results to be obtained (performance) and discourage innovation.

Penalty provisions are severe and provide both civil and criminal remedies for <u>any</u> violation or false information, however minor, which can be construed to be "knowing and willful."

Increasing demands are now being made to furnish the government with proprietary interpretative data which is the heart of competition for OCS leases and the culmination of the exploration effort and skill of a company.

In addition to the ever-increasing and onerous regulatory burden imposed by the federal government, coastal states and communities have been afforded a tool through the Coastal Zone Management Act to indefinitely delay, or veto, OCS sales and exploration and development activities. In the name of potential "onshore impacts" operators on the OCS are required to furnish an open-ended array of information and data ranging from biological studies to potential for local employment. This information is furnished to states whose borders are often hundreds of miles away from the proposed offshore activity and onshore support activities.

The foregoing is but a brief description of the regulatory complex affecting OCS activities and does not include paramount issues of federal control of product price, disposition of royalty oil and access to prime federal lands in the OCS. From an industry perspective the regulatory complex imposed on OCS operations is confusing and lacks definitive purpose. In the context of other industrial activities the regulations imposed on the OCS industry appear to be burdensome. Further, it seems that the OCS industry has been subjected to microscopic examination in isolation from the real world in an attempt to correct by regulation each minute flaw without regard to the relative importance of the flaw compared to natural occurrences, other societal or industrial activities and risks routinely accepted by society. In any case, with few exceptions, it is difficult to discern any beneficial effect of present OCS regulations toward improving the energy supply of this nation.

Actions Needed to Correct OCS Regulatory Problems

If the existing costly and burdensome regulatory complex imposed on OCS operations is to be streamlined and become cost-effective, Congress and the Administration must be dedicated to improve and attempt to resolve our national energy problem, must publicly recognize that the OCS holds the greatest potential future supply of domestic oil and gas, and must be willing to take legislative and administrative actions to encourage rather than impede energy development. When such attitudes are prevalent in the Administration and in Congress, several corrective actions are possible. Such actions include the following:

A. DESIRABLE ADMINISTRATIVE ACTIONS

- Require all departments and agencies of the federal government (particularly DOI, DOE, EPA and the U.S. Coast Guard) to:

  (a) List all regulatory provisions affecting OCS operations,
  (b) Quantify in specific terms the benefits obtained from each regulatory requirement, and
  (c) Eliminate all regulations (not specifically mandated by statute) without quantifiable and demonstrable benefit.

- Further, require that all remaining (discretionary) regulatory requirements be subjected to cost-benefit analysis taking into account, not only the direct costs to industry, but also the cost of government and the cost of delays occasioned by the regulation.

- Require that all regulations specifically mandated by statute be subjected to cost-benefit analysis and that a report be submitted to appropriate congressional committees recommending needed legislative action.

- Require each OCS permitting agency (1) to establish and publish permit conditions for OCS exploratory drilling prior to each lease sale, and (2) be prepared to commence active processing of permit applications within 30 days after each sale.

- DOI and DOC should work with "affected" states in each sale to predetermine and unify data requirements for CZM consistency certification.

- All new regulations imposed on OCS operations should be subjected to quantitative cost-benefit analysis.

- Within constraints of statutory authority all cost beneficial regulations should be rewritten into performance oriented requirements.

- Regulatory data requirements should be reviewed and modified to limit submittals to those data which are demonstrably necessary and useful in government decision making.

- A joint study should be undertaken by DOI, DOC and EPA of existing research relative to environmental impacts of OCS drilling, development and production activities. Study results should be reviewed by the National Academy of Sciences.

B. DESIRABLE LEGISLATIVE ACTIONS

- Legislation to mandate any or all of the foregoing needed administration action.

- Legislation to limit citizen suits on energy projects and to mandate expedited judicial hearings.

- Amendment of the Coastal Zone Management Act to eliminate presale consistency review and to limit post sale consistency determinations (and data requirements) to those actions which cause a physical impact within state boundaries.

- Amend the OCS Lands Act or the Clean Air Act to exclude normal OCS power sources from air quality regulations.

- Require the GAO to make a study to determine how federal agency and department policies, regulations and procedures have affected leasing and development of OCS oil and gas reserves.

- Amend the OCS Lands Act to give total regulatory responsibility for OCS permits to the USGS and the USCG.

O. J. Shirley is Manager, Government Affairs, for Shell Oil Company's southern region in New Orleans, Louisiana. Mr. Shirley is a member of the Committee on Assessment of Safety of Outer Continental Shelf Activities.

NOTES

1. For example, the regulation of OCS pipelines is confusing because field offices of the Office of Pipeline Safety and the USGS do not honor a Memorandum of Understanding between the agencies; EPA and USGS have overlapping jurisdiction and regulations on environmental matters; DOE and DOI each have addressed "diligence" requirements; etc.
2. Shirley, O. J., "The Cost of Regulatory Compliance on the Outer Continental Shelf: Report on an Industry Survey," in National Research Council, Safety and Offshore Oil: Background Papers of the Committee on Assessment of Safety of OCS Activities, Marine Board. National Academy of Press, Washington, D.C., 1981.

THE INTERNATIONAL REGIME FOR OFFSHORE SAFETY

by

Myron Nordquist

Under both customary international law and the 1958 Continental Shelf Convention, the coastal State has sovereign and exclusive rights for purposes of exploring and exploiting the resources of the shelf. As stated by the International Court of Justice in the 1969 North Sea Continental Shelf Cases,[1] the "most fundamental of all the rules of law relating to the continental shelf, enshrined in Article 2 of the 1958 Geneva Convention, though quite independent of it,. . ." is that

> . . . the rights of the coastal State in respect of the area of continental shelf that constitutes a national prolongation of its land territory into and under the sea exist ipso facto and ab initio, by virtue of its sovereignty over the land, as an extension of it in an exercise of sovereign rights for the purpose of exploring the seabed and exploiting its natural resources. In short, there is here an inherent right.

Article 2 of the Continental Shelf Convention provides inter alia that:

> 1. The coastal State exercises over the continental shelf sovereign rights for the purpose of exploring it and exploiting its natural resources.
>
> 2. The Rights referred to . . .are exclusive in the sense that if the coastal State does not explore the continental shelf or exploit its natural resources, no one may undertake these activities . . . without the express consent of the coastal State.

It is clear from these provisions that the coastal State has exclusive regulatory authority, including the establishment of safety standards and rules, over oil and gas installations on the continental shelf. The rights of the coastal State are further defined and limited in Articles 3, 4, and 5 of the Convention. Thus, these rights "do not affect the legal Status of the superjacent waters as high seas, or that of the air space above these waters" (Art. 3) and "[S]ubject to its right to take reasonable measures for the exploration . . . and exploitation [of the shelf], the coastal State may not impede the laying or maintenance of submarine cables or pipelines . . ." (Art. 4). Also, the exploration and exploitation "must not result in any unjustifiable interference with navigation, fishing or the conservation of the living resources of the sea . . . or any interference with . . . scientific research . . . " (Art. 5(1).

Specific reference to safety zones is contained in paragraphs 2 to 7 of Article 5:

> 2. Subject to the provisions of paragraphs 1 and 6. . ., the coastal State is entitled to construct and maintain or operate on the continental shelf installations and other devices necessary for its exploration and the exploitation of its natural resources, and to establish safety zones around such installations and devices and to take in those zones measures necessary for their protection.
>
> 3. The safety zones . . . may extend to a distance of 500 metres around the installations . . . ships of all nationalities must respect these safety zones.
>
> 4. Such installations and devices, though under the jurisdiction of the coastal State, do not possess the status of islands . . . [and] have no territorial sea of their own . . . .
>
> 5. Due notice must be given of the construction of any such installations, and permanent means for giving warning of their presence must be maintained. Any installations which are abandoned or disused must be entirely removed.
>
> 6. Neither the installations or devices, nor the safety zones around them, may be established where interference may be caused to the use of recognized sea lanes essential to international navigation.
>
> 7. The coastal State is obliged to undertake, in the safety zones, all appropriate measures for the protection of the living resources of the sea from harmful agents.

It is clear from paragraph 4 that installations and devices for exploration or exploitation ar[illegible] under coastal State jurisdiction. As stated in the Internatior[illegible]w Commission (ILC) Commentary to this Article, they are subject to regulations issued by the coastal state "For the purpose of maintaining order and of the civil and criminal competence of its courts."[2] This would include safety measures and registration requirements. A problem arises with respect to mobile continental shelf devices, such as drilling ships and self-propelled, semisubmersible drilling rigs, which may arguably be considered ships. Under international law, ships on the high seas (including the superjacent waters of the shelf) are subject to the exclusive jurisdiction of the flag State. A conflict may arise should the coastal State attempt to impose its criminal or civil jurisidiction on a driling ship of foreign registry for infringement of its safety regulations.

A further ambiguity concerns the extent of the coastal State's jurisdiction in the safety zones. Paragraph 2 of Article 5 provides that the coastal State may "take in those zones measures necessary for their protection," without specifying the kind of measures that may be taken. Although ships of all nationalities are directed by paragraph 3 to respect the safety zones, it is unclear whether the coastal State may subject a foreign flag vessel to its criminal or civil jurisdiction for an infringement of its safety regulations in the zone. It will be recalled that paragraph 1 provides that continental shelf operations "must not result in any unjustifiable interference with navigation, fishing or the conservation of the living resources of the sea, nor result in any interference with fundamental oceanographic or other scientific research. . . . ." The ILC Commentary on this provision states that:

> . . .The case is clearly one of assessment of the relative importance of the interests involved. Interference, even if substantial, with navigation and fishing might, in some cases be justified. On the other hand, interference even on an insignificant scale would be unjustified if unrelated to reasonably conceived requirements of exploration and exploitation of the continental shelf. . . .

This general directive offers little guidance in situations where the conflicting interests may be of comparable importance, and in any case does not indicate the authority whose assessment of the relative importance is to prevail.

Similar problems of interpretation arise in connection with paragraph 6, which prohibits the establishment of installaions or devices, and of safety zones, "where interference may be caused to the use of recognized sea lanes essential to international navigation." The phrase "recognized sea lanes essential to international navigation" is not defined in the Convention and is subject to possibly conflicting interpretations.

Again, the provision of Article 4 that the coastal State may not impede the laying or maintenance of submarine cables or pipelines on the continental shelf is made "[S]ubject to its right to take reasonable measures for the exploration . . .and exploitation . . . ." Reasonable measures" are not defined, but would presumably include measures to ensure the safety of continental shelf operations. This interpretation is reinforced by the requirement in Article 5(5) that permanent means of giving warning of the presence of offshore installations be maintained.

Part VI of the Informal Composite Negotiating Text, Revision 2 (hereafter ICNT) which deals with the continental shelf, contains provisions many of which are almost identical to the 1958 Convention. Articles 77, 78, and 79, for example, are derived from Articles 2, 3, 4, and 5 of the 1958 Convention. Offshore installations are specifically covered in Article 81, "The coastal State shall have the exclusive right to authorize and regulate drilling on the continental shelf for all purposes," and in Article 60, "Artificial islands, installations and structures in the exclusive economic zone," which, by Article 80, applies equally to the installations on the continental shelf. Article 60, paragraphs 1 and 2 read:

> 1. In the exclusive economic zone, the coastal state shall have the exclusive right to construct and to authorize and regulate the construction, operation and use of: . . .
>
> (b) Installations and structures for the purposes provided for in Article 56 [exploring and exploiting, conserving and managing the natural resources and other activities for the economic exploitation and exploration of the zone] and other economic activities . . .
>
> 2. The coastal State shall have exclusive jurisdiction over such artificial islands, installations and structures, including jurisdiction with regard to customs, fiscal, health, safety and immigration regulations.

This latter provision goes further than the 1958 Convention in establishing the authority of the coastal State with regard to health and safety regulations. Paragraphs 3 and 8, dealing with notice and warning of such structures, and the fact that they do not affect the delimitation of the territorial sea, economic zone, or continental shelf, are substantially similar to Article 5, paragraphs 4 and 5 of the 1958 Convention.

The establishment of safety zones is dealt with in paragraphs 4 to 7 of Article 60. Paragraph 4 reads:

> 4. The coastal State may, where necessary, establish reasonable safety zones around such . . . installations and structures in which it may take appropriate measures to ensure the safety both of navigation and of the . . . installations and structures.

This provision clarifies, to some extent, the ambiguity contained in Article 5(2) of the 1958 Convention, in that it confirms the authority of the coastal State to take some measures to ensure the safety of both navigation and the structures themselves. However, the distinction is maintained in this text between the installations and structures, where the coastal State has exclusive jurisdiction, including jurisdiction to regulate for safety, and the safety zones, in which it may merely "take appropriate measures to ensure the safety . . . of navigation and of the . . . structures." It is clear from paragraph 6, which states that "[A]ll ships must respect these safety zones and shall comply with generally accepted international standards regarding navigation in the vicinity of artificial islands, installations, structures and safety zones," that any coastal State regulations affecting navigation must comply with international standards, to be enforceable against foreign vessels. Again, Article 60, paragraph 7 repeats the prohibition of Article 5(6) of the 1958 Convention against the establishment of either offshore installations or safety zones "where interference may be caused to the use of recognized sea lanes essential to international navigation."

It should also be mentioned that the ICNT retained the maximum limit of 500 meters for safety zones. Article 60, paragraph 5 reads:

> 5. The breadth of the safety zones shall be determined by the coastal State taking into account applicable international standards. Such zones shall be designed to ensure that they are reasonably related to the nature and function of the . . . installations or structures, and shall not exceed a distance of 500 metres around them. . .except as authorized by generally accepted international standards or as recommended by the appropriate international organizations.

It should be noted that a fixed limit of 500 meters has been widely criticized as inadequate to protect many offshore installations whose underwater cables extend to 1000 meters or more.[3] It is therefore desirable that some flexibility has been introduced into the ICNT text in allowing for deviations from the limit "where authorized by generally accepted international standards or as recommended by the appropriate international organizations."

With regard to enforcement of coastal State laws and regulations, a significant distinction is made in the ICNT text between the living resources of the economic zone and the mineral resources of the continental shelf. Article 73 in Part V ("Exclusive Economic Zone") provides in part:

> 1. The coastal State may, in the exercise of its soverign rights to explore, expoit, conserve and manage the living resources in the exclusive economic zone, take such measures, including boarding, inspection, arrest and judicial proceedings, as may be necessary to ensure compliance with the laws and regulations enacted by it in conformity with this Convention. . . .

There is no comparable enforcement provisions with respect to laws and regulations enacted regarding mineral resources of the continental shelf. Consequently, the extent to which the coastal State may enforce its safety or other regulations for offshore operations is unclear.

Although the "appropriate international organizations" responsible for establishing standards for navigational safety are not identified in the ICNT text, it is clear that the rules adopted by IMCO, whether embodied in international conventions or in resolutions adopted by the Assembly recommending regulatory action by member governments, have an international authority that arguably reaches beyond State parties and member governments.

With regard to safety zones, the relevant IMCO recommendations are contained in Resolution A.379(X) of November 14, 1977 on Establishment of Safety Zones and Fairways or Routing Systems in Offshore Exploration Areas.[4] The Resolution reads:

> Recognizing the need for ensuring unencumbered exploitation of seabed resources as well as safety at sea,
>
> Recognizing further that the congestion of navigable waters by offshore platforms or other similar structures could result in ships colliding with such structures thereby causing loss of life, pollution of the marine environment and economic loss . . .
>
> Noting that in accordance with Article 5 of the 1958 Convention on the Continental Shelf, governments may establish safety zones, extending to a maximum distance of 500 metres which should be respected by ships of all nationalities.
>
> Being informed of the frequent infringements of safety zones by ships,
>
> Recommends that governments:
>
> (a) ensure that the exploitation of seabed resources does not seriously obstruct sea approaches and shipping routes;
>
> (b) study the pattern of shipping traffic through offshore resource exploration areas at an early stage so as to be able to assess potential interference with marine traffic passing close to or through such areas. . .
>
> (c) where proliferation of oil installations or changes of traffic pattern warrants it, consider as appropriate the designation of safety zones around offshore platforms and other similar structures or the establishment and charting of fairways or routing systems through exploration areas.
>
> Urges governments:
>
> (a) to take all necessary steps to ensure that ships under their flags, unless specifically authorized, do not enter or pass through duly designated safety zones;
>
> (b) to promulgate by all appropriate means details of designated safety zones and established fairways or routing systems, taking into account resolution A.341 (IX) on the Dissemination of Information, Charting and Manning of Drilling Rigs, Production Platforms and Other Similar Structures.

The major international conventions dealing with maritime safety in general are the 1974 International Convention for the Safety of Life at Sea ("the SOLAS Convention") and the 1972 Convention on the International Regulations for Preventing Collisions at Sea.[5] The SOLAS Convention[6] applies to ships engaged on "international voyages" defined as "a voyage from a country to which the present Convention applies to a port outside such country, or conversely" but does not apply to, inter alia, warships, fishing vessels, small cargo vessels, and "ships not propelled by mechanical means." It sets out detailed regulations governing construction and equipment, lifesaving appliances, radio telegraphy and telephony, safety of navigation generally, and carriage of grain and of dangerous goods, applicable to passenger ships ("a ship carrying more than 12 passengers"), cargo ships ("any ship which is not a passenger ship") and tankers. A proposed separate category of "industrial vessels" covering for example, drilling rigs, derrick barges and construction and dredging barges, was not adopted. Consequently such structures will be covered by the Regulations as cargo ships, if they are considered to be "ships" at all. The Convention does not contain a definition of "ship." The chapter on Safety of Navigation, which applies to "all ships on all voyages" includes regulations on routing, manning, navigational aids, nautical publications and rescue operations. The routing regulation (No. 8) recommends the use of traffic separation schemes and routing, including avoidance of passages in "areas to be avoided." While IMCO is recognized as "the only international body for establishing and adopting measures on an international level concerning routing and areas to be avoided," the primary responsibility for the selection of routes and the initiation of action regarding them rests with the "governments concerned." Contracting governments agree to "use their influence to secure the appropriate use of adopted routes, and to do every thing in their power to ensure adherence to the routing measures adopted by IMCO. As regards manning, they undertake to adopt and maintain measures to ensure that national ships are "sufficiently and efficiently manned."

The 1972 Prevention of Collisions Convention, which came into force of July 15, 1977, contains revised Collision Regulations applicable "to all vessels on the high seas and in all waters connected therewith navigable by seagoing vessels." "Vessel" includes "every description of water craft, including non-displacement craft and seaplanes, used or capable of being used as a means of transportation on water." There is a special category of "Vessels restricted in their ability to maneuver" which includes vessels engaged in dredging, surveying or underwater operations, or in replenishment or transferring persons, provisions, or cargo while underway, and those "engaged in a towing operation such as renders (her) unable to deviate from her course." The regulations cover a range of measures to prevent collisions including steering and sailing rules governing the conduct of vessels in different conditions of visibility, lights and shapes, and sound and light signals. A significant change from the earlier regulations is the new Rule 10 which makes the traffic separation schemes adopted by IMCO compulsory. Over 200 such schemes have been adopted by IMCO to date. It should be noted, however, that the principle of exclusive flag State jurisdiction applies to violations of such schemes on the high seas and the Convention and annexed Regulations bind only states parties.

In an attempt to deal with some of the jurisdictional problems arising out of collisions and similar maritime incidents, three Conventions were signed in May 1952. The International Convention for the Unification of Certain Rules Relating to Penal Jurisdiction in Matters of Collision or Other Incidents of Navigation,[7] provides that only the flag State may institute criminal proceedings or arrest the ship in cases involving the penal or disciplinary responsibility of persons in the ship's service. The International Convention Relating to the Arrest of Sea-Going Ships[8] allows the arrest of ships of Contracting States within the jurisdiction of another Contracting State "in respect of any maritime claim" only. The International Convention on Certain Rules Concerning Civil Jurisdiction in Matters of Collision[9] gives plaintiffs the choice of forum between the country where the defendant has his residence or place of business, or where the arrest of the ship, or another of defendant's ships, took place, or where bail was granted.

In conclusion, the major problem with regard to the international regime governing safety of offshore operations is the ambiguity regarding the extent of the coastal State's authority to establish and enforce safety regulations against foreign vessels, particularly in the safety zones, and the potential conflict between flag State and coastal State jurisdiction in this regard. Even if coastal State regulations follow the rules and standards established by IMCO or set out in international Conventions to help ensure their international acceptability to a certain extent, the problem of enforceability against non-members of IMCO or non-parties to these Conventions remains. Further, the uncertain status of mobile offshore rigs and similar structures presents additional opportunities for confusion or conflict.

Myron H. Nordquist is an attorney with Nossaman, Krueger and Marsh, Washington, D.C. He is a member of the Marine Board and of the Committee on Assessment of Outer Continental Shelf Activities. Mr. Nordquist specializes in natural resources law, international law, and federal administrative law. He is also Adjunct Professor, George Washington University School of Law.

NOTES

1. ICJ Reports, 1969.
2. (1956) ILC Report, Vol. II. The ILC prepared draft articles with a corresponding commentary for the consideration of delegates at the First United Nations Conference on the Law of the Sea held in 1958.
3. Maritime experts have also pointed out that many of the larger tankers cannot be brought to a stop within 500 meters.
4. Reproduced in Ruster, Simma and Bock, eds., International Protection of the Environment, (Dobbs Ferry: Oceana, 1979,) Vol. XIX, p. 9794. This resolution revoked the earlier Resolution on Fairways, A.340(IX).
5. Reproduced in Churchill and Nordquist, eds. New Directions In the Law of the Sea, (Dobbs Ferry: Oceana, 1975) Vol. IV, p. 245.
6. IMCO, International Conference on Safety of Life at Sea, London, 1974.
7. 439 UNTS 233 in force November 20, 1955. Parties include Belgium, Federal Republic of Germany, the Netherlands and the United Kingdom.
8. 439 UNTS 193 in force February 26, 1906. Parties include Belgium, Federal Republic of Germany and the United Kingdom.
9. 439 UNTS 217, in force September 14, 1955. Parties include Belgium, Federal Republic of Germany and the United Kingdom.

INSURANCE IN THE OFFSHORE OIL INDUSTRY

by

Robert C. Phillips

Insurance Markets

The offshore oil industry is serviced by the same commercial insurance markets which furnish insurance to all other businesses and commercial activities. In the United States and many other countries, insurance can be roughly divided into two major markets: casualty-property and ocean-marine. The casualty-property market provides a wide variety of commercial insurance such as property (fire, windstorm, etc.), general liability, workers' compensation, boiler machinery, and surety to commercial enterprises. The ocean-marine market provides similar coverages to businesses engaged in various forms of maritime commercial enterprises. The two markets operate in parallel, one concentrating on shore-based enterprise and the other on maritime-based enterprise.

Certain types of businesses, such as marine construction, dredging, and offshore oil are conducted both ashore and afloat. These businesses may buy insurance in both of the insurance markets. The placement or purchasing of insurance varies widely from one company to another and depends heavily on the insurance brokers or agents involved. However, many businesses involved in offshore development will buy conventional general liability, workers' compensation, and property insurance from the casualty-property market, and ocean-marine hull insurance (marine property) from the ocean-marine insurance market.

Further, casualty-property underwriters specifically tend to avoid writing maritime property coverages on floating hulls and ocean platforms, leaving this business area to the ocean-marine underwriters.

Several pools, headed by marine-knowledgeable underwriters, have been formed to provide property coverage on offshore oil rigs. The pools were formed as a result of the very high values involved, the relatively high degree of risk, and the specialized nature of the risk. These pools include some companies who are also engaged in the casualty-property business.

Generally, it can be said that the casualty-property market can cover the majority of the exposures involved in the offshore business. The ocean-marine market limits its cover to the exposures generated by those activities that are purely maritime in character, such as hull insurance for MODU's.

These insurances are available in the domestic United States marketplace. However, similar insurances can be bought in the London market, and often are, when a company encounters difficulty in placing insurance domestically at a favorable price.

Although there are brokers who tend to specialize in providing insurance for offshore industries, these brokers use the same insurance carriers (insurance companies) to provide the insurance, as do any other brokers, serving other industries.

Types and Levels of Insurance

Almost invariably companies operating in the offshore oil business will require general liability coverage, workers' compensation, and property coverages, together with ocean-marine policies covering their marine property (hulls) and marine liabilities. Often the casualty-property companies will cover workers' compensation in the marine environment and sometimes the maritime liabilities (in effect, overlapping the territory of the ocean-marine underwriter).

The levels of insurance carried by companies in the offshore business vary widely depending on the nature of the particular business and the potential for loss. However, most companies carry at least primary coverage including that for all workers' compensation losses, general liability up to one or two million dollars, and property damage up to 10 to 15 million dollars. When the potential for losses exceed these levels, a company may purchase excess layers of insurance up to the amounts required. Typically, a small company may purchase liability coverages up to 1 or 2 million dollars. A major oil company might purchase several layers of insurance covering them for liability up to a limit as high as 200 million dollars or more. Property insurance is purchased with limits to cover the actual value of any tangible property owned.

Many large companies elect to retain some of the risk themselves. One way to do this is to buy insurance with large deductibles. Another method is to buy insurance on a retrospective rating plan. In such a plan the insurance buyer pays a "standard" premium. He then receives a refund if his losses are below certain levels. If the levels are exceeded, he may pay a higher premium. In effect, he is directly motivated to reduce losses so as to reduce his premium. In some such plans he virtually pays for most of his losses, with the insurance carrier managing and paying the claims, and providing insurance only against the very large and unexpected claims.

Insurance Regulation

The rate structure of the casualty-property market is tightly regulated by individual state insurance commissioners. The ocean-marine market is, however, unregulated and is much better able to adjust its rates to various situations. Because his market is regulated and therefore less flexible, the casualty-property underwriter may be reluctant to get involved with unusual or unknown risks such as those associated with new technologies. It is important to understand that the matter of insurance regulation is entirely separate from the matter of adjudicating claims. While the states control or regulate underwriting practices and premium charges for casualty-property insurance policies (which sometimes extend coverage to activities located on the OCS), they have not seen fit to extend similar controls over the ocean-marine underwriters operating within their jurisdiction. However, an insurance policy is essentially a contract, regardless of the market in which it is written. When a claim occurs that must be adjudicated, because it cannot be settled under ordinary claim handling procedures, the matter is referred to a court having competent jurisdiction. If the claim occurs on navigable waters (including the Outer Continental Shelf area) it is normally processed in a U.S. federal court under Admiralty principles. This is independent of which insurance market provides the coverage and irrespective of the geographical location of the underwriter.

Perhaps a good example is that claims on offshore activities in the United States, covered by insurance from the London market, are adjudicated in the U.S. federal courts under Admiralty principles.

Purchasing of Insurance

Up until about 1970, most insurance was purchased by an insurance buyer or insurance manager. The level of this person in most corporations was relatively low. Gradually, insurance managers have given way to risk managers who occupy a substantially improved stature in many corporations. These individuals have become very knowledgeable and sophisticated in the handling of risk. Insurance is one way of handling risk. Another way is to improve loss control techniques and retain much of the risk in-house. The retrospective rating plans, previously described, are still another way of retaining some risk while insuring against large or catastrophic losses. There is also a substantial movement by larger companies, including many of those engaged in OCS operations, to go self-insured. There are various techniques for accomplishing this. When a company is self-insured, it has a strong motivation to control losses, and must do so to avoid serious financial difficulties. However, it is important to recognize that only the very large companies can normally implement a self-insurance program. The smaller companies must still rely on conventional guaranteed cost insurance.

Controlling Losses

Traditionally and theoretically, insurance has been considered a logical economic lever to motivate industry to control losses. The theory is that a company will control losses in order to reduce insurance premium costs. In the self-insurance systems, previously described, the controlling of loss directly results in reduced insurance costs. However, a number of factors can inhibit this mechanism. For example, most of the smaller companies buy guaranteed cost insurance. In this case, the underwriter may be reluctant to discount his rates until at least several years of demonstrated loss control effectiveness have passed. Also a casualty-property underwriter has limited flexibility to reward good performance with lower rates, because of state regulations. Some large companies apportion their insurance costs among field managers in amounts proportional to their incurred losses. This produces a strong motivation to the operating manager to control loss. However, for various reasons, many corporations prefer not to apportion insurance costs, and therefore lose the benefit of this motivation to control loss.

Complicating Factors

Most of the personnel in the offshore oil business fall within the jurisdiction of the Jones Act, Death on the High Seas Act, or the U.S. Longshoremen's and Harbor Workers' Act. These acts provide the legal basis for compensating offshore workers who are injured or killed. They also constitute the single most important problem in furnishing insurance coverage for the offshore oil industry.

The Jones Act provides that compensation for injuries and deaths on floating units offshore can be obtained by suing the employer. Thus, most injuries on any kind of floating unit result in a suit which must be defended (or settled) by the insurance company providing workers' compensation (and employer's liability) insurance. There are no limits on the amount for which the plaintiff can sue and the amounts paid are controlled only by custom or precedents from preceding cases. Similar suits may be brought under the Death on the High Seas Act or through other legal avenues. Personnel injured on fixed platforms, or on locations near or over the water, usually come under the jurisdiction of the U.S. Longshoremen's and Harbor Workers' Act. This act establishes a federal workers' compensation scheme with benefits and provisions that are substantially more liberal than most state workers' compensation acts. Further, the provisions are such that it is difficult to determine the maximum dollar exposure to the insurance company. The underwriters are reluctant to provide the relatively nebulous coverage since they are regulated as to the amount of premium they can charge for the coverage. Due to the amounts of money often involved, injured parties normally engage legal counsel. There may be substantial legal expense to the insurance carrier in adjusting the claim. Thus the settlements on offshore injury and death claims tend to be quite high, and ofter involve large legal expenses.

Another complicating factor, relatively unique to the oil industry, is the fact that the employees of many different contractors and subcontractors normally work in close proximity on the platforms, drilling rigs, and vessels. When an injury or death occurs, it is common for the injured man to obtain an attorney, who then may bring suit against all other companies represented on the rig, regardless of their particular involvement or responsibility. This adds to the number of liability suits which the insurance company must defend for any client who carries general liability coverage. The problem results not from defending the insured for situations in which he is actually culpable or negligent, but in defending suits which are largely groundless, often at considerable expense. The number of such suits in which an insured is likely to be involved is impossible to estimate. These complicating factors have become gradually more acute since the 1972 Amendments to the U.S. Longshoremen's and Harbor Worker's Act and as the litigous climate has increased in the U.S.

Contractors and Subcontractors

Most underwriters are not willing to provide high limits of insurance (particularly for general liability coverage) for relatively small businesses. As a result, small contractors operating offshore may be limited to $500,000 to $1,000,000 on their primary insurance. In addition, they may be able to purchase an umbrella policy over the primary liability policy, with limits to about 5 million dollars. Their potential for creating larger losses while working on offshore platforms or drilling rigs may considerably exceed such limits. For example, if they cause a major fire, explosion, or well blowout, and this is not uncommon, the potential dollar loss could be catastrophic (100 million dollars or more). Most major oil companies and the large drilling contractors will require in the contract, for such contractors and subcontractors, that certain minimum levels of insurance be provided. For example, they may require their subcontractor to purchase $250,000 or $500,000 limits on the employer's liability portion of the workers' compensation coverage, and $500,000 or $1,000,000 limits on general liability. The major oil company (or major drilling contractor) must then assume, through his insurance, liabilities generated by his subcontractor which exceed these levels. Under these circumstances, some offshore contractors are not bearing their own proportion of the risk that they generate.

Comparison of Risks

It is difficult, if not impossible, to make quantifiable comparisons between the offshore oil industry and other similar risks. The offshore industry has the potential of generating large workers' compensation losses since relatively large numbers of employees are concentrated on small platforms, vessels or helicopters, and mobile drilling rigs. Thus, multiple injuries or deaths are possible, which would result in large dollar losses because of the Longshoremen's Act and Jones Act. Blowouts, or other accidents resulting in large oil spills, can generate very large liability losses. Blowouts, fires, or explosions can also cause large property losses. However, some other industries can generate comparable losses. Chemical and pesticide companies, for example, can generate large liability and workers' compensation losses. Timber and logging companies generate very large property losses. Many manufacturing companies may tend to have lower potentials for large loss but this can vary depending on their product. If they produce a product which causes widespread injury or illness they may also incur catastrophic liability losses.

The one difference in the offshore industry is that it generally operates both ashore and afloat (or on fixed platforms in the water). For this reason it requires a combination of casualty-property and ocean-marine coverages. In order for an underwriter to properly underwrite such a risk, he must understand both types of coverages so that they can be dovetailed. Many underwriters do not have this dual knowledge and are uncomfortable working with a risk that has potential exposures with which they are unfamiliar. This "fear of the unknown" may lead to the conclusion on the part of some that the offshore industry is particularly risky, when in fact it is comparable to other high hazard risks.

Insurance Company Safety Data

Insurance companies collect data in order to manage their financial activities, and to satisfy the many reporting requirements generated by state regulators. Most insurance data is financial in character: premiums collected, dollar amounts for claims, claim expense dollars, overhead expense, etc. Data with respect to causes of loss are not normally as accurate or as complete. The develoment of accurate causal data is expensive since it requires considerable investigative effort for each loss (claim). The insurance company does not need detailed causal data in order to settle a claim. They need only enough information to verify that the claim is legitimate and is actually covered by the policy. The financial data collected is adequate to indicate what premium rates are required to cover certain occupations and activities. Similar data, furnished to state regulators, is used by the state to prescribe and/or regulate premium rates for the casualty-property business. As previously noted, the ocean-marine underwriter is free to set his own rate from whatever data he generates.

It is doubtful that available insurance data would add much to the OCS safety data base, particularly with respect to cause. It could be used to indicate the dollar figures for personnel injury, disability and property damage claims. However, since such coverages are usually written to cover all company activities, it would be difficult, if not impossible, to separate statistics on only those claims occurring on the Outer Continental Shelf. It is doutbful that any insurance company has statistics isolated to claims occurring only on the Outer Continental Shelf. Some insurance data could possibly be manipulated to obtain comparative claim dollar losses between various different offshore occupations. That insurance data which has been examined in this study has tended to be consistent with loss data generated from other sources. That is, it has produced no unusual surprises except one. It seems to indicate that when a man is injured offshore by slips, falls, being struck, being crushed, or by other means, he has a high risk of incurring serious back injuries. It is difficult to account for this except that it is known that back injuries are difficult to diagnose, evaluate, and treat. They, therefore, are a convenient type of injury to allege in the many suits which are brought in the offshore business. However, the data also show that most of those who allege back injuries receive one or two back operations. This seems to indicate that some substantial back injury has actually occurred.

Robert C. Phillips is Assistant Director of the Commercial Lines Department of the Travelers Insurance Companies, and is a former Coast Guard officer.

OIL SPILL COOPERATIVES
by
Tom E. Allen*

Companies exploring, producing, transporting, and refining oil products are required to submit oil spill contingency plans to various governmental agencies to obtain approval for their operations. Many of the companies have elected to form cooperatives to satisfy all or part of their need for oil spill response. The principal reason for this decision has been economics. The burden of purchasing and maintaining equipment stockpiles is shared by the cooperative members. Individual cooperatives have a particular area of interest such as a port of a particular region of offshore production and exploration. Thus a COOP's equipment stockpile reflects its individual needs. The cooperative generally stockpiles and maintains the equipment and trains members company personnel and third party contractor personnel in the use of its equipment.

An equipment cooperative which has purchased equipment for an exploration activity offshore will normally respond to an oil spill by a tanker mishap. However, most cooperatives have provisions for allowing an "outsider" to utilize their equipment, preference being given to the cooperative members.

Equipment Capability

The stockpile of equipment held by cooperatives generally consists of equipment larger and more expensive than equipment stockpiled by private clean-up contractors. Where private contractors often have a large amount of spill clean-up equipment, it is normally suited primarily to bay and harbor operations. Individual companies who may be members of cooperatives also stockpile their own spill response equipment. Thus, the stockpile of the cooperatives supplements and complements the individual company and private clean-up contractors' capability. The following summarizes the equipment and chemical stockpiles held by seven U.S. cooperatives. They are Gulf of Alaska (GOA), Clean Seas (CS), Southern California Petroleum Contingency Organization (SC-PCO), Corpus Christi Area Oil Spill Control Association (CCAR), Clean Caribbean (CC), Clean Gulf Associates (CGA), and Clean Atlantic Associates (CAA).

*The opinions expressed herein are those of the author and are not to be construed as reflecting the views of his employer, Halliburton Services Company.

Containment Boom

Table 1 summarizes the quantity of containment boom (organized by total height of the boom). Of the cooperatives listed, 79,236 ft. of boom is stockpiled in the size range of 28" in height and greater; 56,044 ft. of boom is stockpiled in the size range of 38" and larger. Table 2 summarized the quantity and manufacture of each boom owned by each cooperative. There are considerable differences in the design and capability of these booms for operating on the OCS. Some of the cooperatives also stockpile large amounts of boom in sizes smaller than those indicated in the table.

Skimmers

Table 3 describes various types of skimmers, and provides information on estimated maximum recovery rates, and the quantity of skimmers stockpiled by the respective cooperatives. It is beyond the scope of this report to try to reflect on the "effectiveness" of the various skimmers in the OCS area. The skimmer's effective operation may be limited to seas as little as 2-3 ft. and as high as 6-8 ft. Many skimming systems stockpiled by the cooperatives that are generally considered to be limited to bay and harbor operations are not listed, while some of the skimmers that are listed may be severely limited in their effectiveness on the OCS. The systems generally require support boats or vessels from which they will be operated. The recovery rate of the skimmers vary 53 gal/min to 200 gal/min. The 69 skimmers listed in Table 3 have a total maximum oil recovery capability of approximately 375,000 bbl per 10 hour day. Some of the systems contain storage capability for recovered fluids and others require separate storage capacity. For a large spill, all of the skimming systems would require significant additional storage capacity.

Recovered Oil Storage Capacity

Table 4 summarizes supplemental storage of recovered fluids (tanks, inflatables, barges and tankers). A total storage volume of 6,300 barrels is in the form of tanks; 2,200 barrels of storage is in the form of inflatables; 18,000 barrels of capacity is in the form of barges; one tanker has a capacity of 10,000 barrels. The total supplemental storage capacity is 36,500 barrels. This capacity would meet only temporary needs in any significant spill.

Chemical Application Equipment and Chemical Inventory

Table 5 summarizes equipment capable of applying dispersants and indicates total volume of chemicals stockpiled by the cooperatives. A total of 15 helicopter spray systems and 15 boat spray systems are stockpiled. Clean Caribbean and SC-PCO have one dedicated C54 four-engine aircraft each for the exclusive use of applying chemical

TABLE 1

Oil Spill Containment Boom - Size vs. Quantity

Boom Size, In. (Total Height)	Total Quantity, Ft., Indicated Size and Larger
28	79,236
30	77,236
34	70,592
36	64,644
38	56,044
42	47,024
43	44,024
44	22,824
60	8,424
72	4,424
96	4,000

TABLE 2

Boom Manufacturer, Size	GOA	CS	SC-PCO	CC	CGA	CAA	Total
Whittaker Expandi[tm] - #3000 (12 x 18)[1] - 30 "		5,527'	5,565'				11,092'
Whittaker Expandi[tm] - #4300 (20 x 23) - 43"	3,000'	9,100'	9,100'				21,200'
Kepner (16 x 12) - 28"		2,000'					2,000'
(12 x 24) - 36"				1,600'			1,600'
(18 x 24) - 42"						3,000'	3,000'
(24 x 36) - 60"						3,000	3,000
Goodyear Seasentry (14 x 24) - 38"		2,710'	6,310'				9,020'
Vikoma (27 x 17) - 44"		3,200'	11,200'				14,400'
Open Ocean (42 x 54) - 96"		2,000'	2,000'				4,000'
Acorn (Acme) (16 x 18) - 34"				2,500			2,500'
Bennett - 36"					5,000'		5,000'
Uniroyal - 36"					2,000'		2,000'
Oil Tech - 72"					424'		424'
						Total	79,236'

NOTE:

1. Size is indicated by (freeboard x draft)

TABLE 3

Skimmers	GOA	CS	SC-PCO	CC	CGA	CAA	Total
Cyclonet - 150 (1600 gpm)	1		1				2
- 100		1	1				2
- 050		1	2				3
Komara (53 gpm)	2	1	4				7
Acme, Weir (300 gpm)	2	6	7				15
Floating, Weir (300 gpm)		3					3
Mark II (200 gpm)		2	4				6
CSI Catamaran Weir Barge (2000 gpm)		1	1				2
Oil Mop, 9" (70 gpm)		2	1				3
Marco, Class I (300 gpm)			1				1
Savoc			4				4
Fast Response, Model I (500 gpm)					7	4	11
Fast Response, Model II (500 gpm)					4	4	8
S.O.C.K.	1						1
H.O.S.S. (2000 gpm)					1		1
						Total	69

TABLE 4

Recovered Oil Storage Capability:
Tanks, Inflatables, Barges and Tankers

Tanks:

100 bbl	Gulf of Alaska	X 2 =	200 bbl
100 bbl	Clean Seas	X 5 =	500 bbl
100 bbl	California	X 2 =	200 bbl
90 bbl	Clean Gulf	X 8 =	720 bbl
90 bbl	Clean Atlantic	X 8 =	720 bbl
180 bbl	Clean Gulf	X 14 =	2,520 bbl
180 bbl	Clean Atlantic	X 8 =	1,440 bbl
			6,300 bbl

Inflatables:

Dracone -	2,500 gal	Gulf of Alaska	X 2 =	5,000 gal
Pillow -	25,000 gal	Gulf of Alaska	X 2 =	50,000 gal
Kepner -	1,200 gal	Clean Seas	X 6 =	7,200 gal
Kepner -	5,000 gal	Clean Seas	X 2 =	10,000 gal
Dracone -	6,000 gal	Clean Seas	X 1 =	6,000 gal
Kepner -	1,200 gal	California	X 4 =	4,800 gal
Kepner -	5,000 gal	California	X 1 =	5,000 gal
Dracone -	1,200 gal	California	X 3 =	3,600 gal
			Total	91,600 gal
			=	2,181 bbl

Barges:

7,840 bbl	Clean Seas	=	7,840 bbl
7,840 bbl	California	=	7,840 bbl
50 bbl	Clean Gulf X 6	=	300 bbl
2,000 bbl	X 1	=	2,000 bbl
		Total	17,980 bbl
Tankers	210 ft	California	10,000 bbl
		Total	36,461 bbl

TABLE 5

Chemical Application Equipment and Chemical Inventory

A. Helicopter Spray Systems (Collectant or Dispersant)

Gulf of Alaska	2
Clean Seas	2
California	3
Clean Caribbean	0
Clean Gulf	4
Clean Atlantic	4
Total	15

B. Boat Spray Systems (Dispersant Only)

Gulf of Alaska	0
Clean Seas	1
California	4
Clean Caribbean	0
Clean Gulf	4
Clean Atlantic	6
Total	15

C. Aircraft, Fixed Wing (Dispersant Only)

Corpus Christi	1	(Dedicated C-54, Four-Engine)
Clean Seas		
California		Cost Shared With the Three Cooperatives

D. Dispersant Stockpile

Gulf of Atlantic	182 drums
Clean Seas	240 drums
California	300 drums
Clean Gulf	60 drums
Clean Atlantic	112 drums
Corpus Christi	500 drums
Total	1,394 drums

dispersants. The total drums of chemicals stockpiled in the cooperatives is 1,394 drums. By assuming a chemical treatment ratio of 20/1 (dispersed oil to chemical dispersant) approximately 30,800 barrels of oil could be dispersed with the chemicals kept on hand.

Summary

Oil Spill Cooperatives have been organized by the oil and gas industry to provide an OCS oil spill response capability. The equipment stockpiled by cooperatives supplements and complements equipment already stocked by industry and private clean-up contractors. Numerous other cooperatives are dedicated to bay and harbor oil spill response. These may have equipment which could be applicable to an OCS spill in some instances.

The total equipment stockpile of OCS cooperatives is 80,000 ft. of boom, 69 skimmers, temporary storage capacity for 36,000 barrels of oil, and 30 pieces of chemical application equipment. Oil recovery capacity of all skimmer systems equals approximately 375,000 bbl per day. The total amount of oil that could be dispersed with the chemical dispersant that is stockpiled is 36,500 bbl. Thus, a significant capability does exist through private cooperatives to respond to spills on the OCS.

Tom E. Allen is a research engineer with Halliburton Services Company, Duncan, Oklahoma, which manages a number of oil spill cooperatives.

COOPERATIVE INFORMATION SOURCES

1. Gulf of Alaska Cleanup Organization
   Contact: Robert Bernhardt

2. Clean Seas
   Contact: Bud Waage

3. Southern California Petroleum Contingency Organization
   Contact: C. J. Campbell

4. Corpus Christi Area Oil Spill Control Association
   Contact: W. A. Sky-Eagle

5. Clean Gulf Associates
   Contact: Bill Ayers

6. Clean Atlantic Associates
   Contact: Tom Allen

7. Clean Caribbean
   Contact: Don Alberts

TRAINING AND QUALIFICATION OF OCS WORKERS*

by

Carl Mangus

The offshore industry has recognized for a long time the need for experienced and trained personnel as well as the need for a low turnover or attrition rate. The benefits of fully qualified people are self-evident in a company's profit picture as well as in its corporate public image.

There are several ways to get qualified people. These include in-house development programs, hiring from outside, use of outside schools or a combination of these. In-house programs vary from essentially 100 percent on-the-job training (OJT) to those heavily accented with training courses. The degree OJT is supplemented varies significantly from company to company. However, as the demand for personnel increases during and in preparation for peak activity, OJT, although best in most skills, becomes too slow and must be accelerated through more formalized training.

The degree supplemental courses are needed is affected by numerous other factors as new equipment, specialized training to simulate actual "crisis" type situations, the depth of the in-house manpower pool, company policy, regulatory requirements and the leasing schedule.

Table 1 illustrates how this approach varies among the member companies of the Offshore Operators Committee (OOC). There is a large spread in the data in the table. Company B is a major company with a good strong in-house supplemental course program. You can see by the number of people working offshore that this is a sizable company. Obviously, it is strong in OJT. Although I do not identify the company, I can assure you that it does not have a high turnover rate; consequently, it has a stable work force. It also does not generally look outside to hire people trained by others. Contrast this record with that of Company E.

In-house training is supplemented by "outside-the-company" training. The American Petroleum Institute attempts to keep count of the many training opportunities of this type.** The compilation

*Condensation of an oral presentation delivered before the Committee on Assessment of Safety of OCS Activities, Reston, Virginia, September 1980.

**American Petroleum Institute Production Department, "Compilation of Training Courses and Materials," American Petroleum Institute, Dallas, Texas, 1979.

TABLE I

Examples of In-house Company Training Programs**

COURSE	A	B	C	D	E	F	G
Offshore Orientation (API RP T-1)	Y	Y	50/50	Y	Y	Y	Y
First Aid	Y	555/781#	72/317	Y	177/517	390/780	Y
CPR	Y	555/781	32/261		204/517	195/780	Y
Safety Device Certification	220/353	55/265		260##	48/475		
Fire Fighting	Y	382/781		235	210/517		Y
Crane Certification	Y	Y			68/517		Y
Well Control	104/169	128/231		156	Y	346/470	Y
Ableseaman/Lifeboatman (USCG)						23/298	
Buoyancy/Stability						80/80	Y
Defensive Driving	Y	115/118		Y	Y	Y	Y
Survival Capsule		572/572		143		Y	Y
H_2S Drilling	Y*	67/133		Y*	Y*	Y	Y*
Product/Drilling Skills OJT not recorded		662/662					Y
Water Survival Training		388/781					

*As needed.

**Limited drilling company input to survey.

#An entry such as 555/781, means 555 employees took the course in 1979, out of 781 employees in the job classifications which normally take this training.

##An entry such as 260 means that 260 employees took this course in 1979.

Y Means course is available in-house but data could not be readily assembled.

is comprehensive and serves as a good base document of the training available to every company regardless as to whether the company uses in-house supplemental courses or not.

As a second portion of this paper with specific aspects of three types of training are discussed:

- o The individual workplace which would include most aspects of occupational safety and protection of the environment from small oil spills.

- o Teamwork responses to "crises" such as fires and explosions; abandonment of structures; etc.

- o Individual and/or teamwork training such as well control or fire fighting.

For individual workplace safety and small spill prevention, the offshore record is good when compared to other geographical areas. There are ample training courses available to all personnel--minimum being that which satisfies the OCS order requirement for training. Probably the most valuable training for this purpose is through on-the-job safety meetings where an individual can discuss noted hazards and recommended solutions with his own peer group.

The prime factor affecting the training of individuals is not controllable by industry. It affects the numbers of entry level people needing supplemental courses (over OJT) as peak level lease activity increases over normal or slack periods. This fluctuation is a direct result of leasing policy and schedules. A short time ago, there were stacked rigs everywhere you looked--now the reverse is true. A strong factor is stability in leasing activity level. The industry can gear up and maintain most any level of activity, but the system has to have stability if training and experienced workers are to be provided and kept in the offshore. The single most effective thing which would improve individual workplace safety and reduce the number of small oil spills would be stability in leasing schedules.

Teamwork responses to "crises" such as fires and explosions, abandonment of structures, etc., are handled by both in-house instruction and outside schools. An example of an in-house program is Exxon's fire fighting school at Grand Isle, Louisiana. Another teamwork training operation is "drill" training for oil spill response teams. OCS Order No. 7, Section 4, provides for drills and training for those personnel identified as the oil spill response operating team in a contingency plan. The drills are to be held at least once every 12 months with USGS approval of the equipment to be deployed.

We question both the need for annual drills, particularly if the team makeup remains fairly constant, and the requirement that a majority of the equipment be deployed at each event.

In one area, the Coast Guard has insisted that the drills be conducted semi-annually at an offshore location with at least one of the exercises being held under the most demanding environmental conditions for which the response mechanism is expected to be effective (i.e., 8-10 foot seas). Hands-on training in deployment ofpollution control equipment should only be conducted under reasonably safe conditions. There is no justification for requiring deployment of equipment in high seas as it is likely to result in serious injury or death to the personnel involved. The equipment need not be tested to failure just as you do not train firefighters to fight raging infernos which could result in their serious injury or death.

Abandonment is a drill type training exercise which has to be conducted using the equipment that is available to a specific crew. Although it is usually conducted at the work site, it can be conducted just as well at other sites so long as the equipment is basically the same.

Abandonment training is mandatory under Coast Guard regulations. In some instances, additional training is required by the Coast Guard, which we do not believe is beneficial. For instance, the test presently used for Ableseamen/Lifeboatmen is not very meaningful to workers on Mobile Offshore Drilling Units (MODUs). Mobile drilling units do not carry open lifeboats. Again, this is another illustration of the pitfalls that you need to be aware of that results from stipulating "how," "when," and "where" in regulatory requirements.

Individual and/or teamwork training is a very visual or public type of training. It is now mandatory for well control. Long before it was mandatory, however, there were schools available. I attended one in 1969 at the University in Lafayette, Louisiana. The Shell White Castle School has been in operation many years and there are numerous similar schools.

It is likely that a worker's training and experience affect his or her safety performance. However, there is no clear-cut answer that requirements for training or experience produce improvements in safety. Part of the difficulty in showing this stems from the difficulty of separating the voluminous voluntary effort from the small required effort. However, we do believe those mandatory requirements such as the Coast Guard "emergency" drill or the USGS "well control" drill which are objective in nature do, in fact, cause a more universal and sincere application of needed training exercises. Beyond this degree the mandatory system begins to break down, it begins to stipulate "how" and "when" rather than an objective.

The ability of the individual is a key ingredient in safety. The full utilization of personnel can only be realized through the flexibility of an experienced supervisor evaluating and determining which individuals are sufficiently trained and experienced (qualified); recognizing, of course, that the supervisor has to work with the personnel he has and that his determination is relative.

Restrictive constraints on ability to operate that can grow out of regulatory training requirements are illustrated by the following examples.

- The current application of requirements for Ableseaman/Lifeboatman to drilling rigs are a waste of time on a drilling unit completely equipped with covered powered lifeboats or capsules, yet by law the vessel cannot operate if the designated number of persons with these endorsements are not on board.

- Similarly, mandatory qualification of relief drilling personnel currently negates the traditional on-the-job approach to personnel development. It requires any relief driller, regardless of supervision or circumstances causing a personnel shortage, to have completed well control training before he uses the break. This situation could force a choice between going without supervision (i.e., the pusher becomes driller) or shutting down the rig. Either approach could be hazardous depending on hole conditions.

The OOC does not believe mandatory training requirements will materially affect safety in frontier area operations and industry's ability to expand into those areas any differently than in mature areas as long as the requirements are the same. There is no doubt that mandatory training requirements which set "how" or "when" personnel can be used in a job will restrict and hamper industry's ability to effectively perform. The degree depends on a lot of factors--a key one being stability in lease sales.

Putting cost numbers to possible mandatory training requirements is extremely difficult if not impossible. The extreme of the "relief driller" requirement could be a lost rig or a lost well; however, we would certainly hope it would be limited to the lost time necessary to locate and fly in a spare driller.

Another factor in the evaluation of the need for mandatory training requirements is posed by the question, "Are companies, large and small, sufficiently motivated to assure adequate training?" It is safe to conclude that all operating companies are aware that the more qualified their staff the better performance they get. It is also safe to conclude that there is a cost-benefit relationship which will govern how well they need to be trained. The overwhelming training activity and availability of schools and courses of instruction for the offshore worker shows that industry as a whole is highly motivated to develop qualified personnel whether it be because of better profits, corporate responsibility, or other reasons.

The area of least motivation to train personnel lies with labor contractor type companies where there is a very unstable work force with an extremely high turnover rate. The OOC recognizes this is a problem area. Although only a minimum of training is needed, it is still difficult to achieve a high degree of that training when a sizable number may only make one hitch with the company.

Carl Mangus is the Regulatory Response Coordinator for Shell Oil Company's Offshore Division in New Orleans, Louisiana.

THE COST OF REGULATORY COMPLIANCE ON THE OUTER CONTINENTAL SHELF: REPORT ON AN INDUSTRY SURVEY

by

O. J. Shirley

Summary and Conclusions

Summary

The Committee on Assessment of Safety of OCS Activities required information on the cost of regulatory compliance as one input to its deliberations. This report responds in part to that need by providing data on one segment of industry's cost of compliance--e.g., the amount of effort and cost of personnel devoted to regulatory activities. Other significant costs to industry and the cost of government are described in this report, but no findings are made because of the complexity of obtaining meaningful data or lack of appropriate response by federal agencies. Thus, the reader should be aware that the data presented represents a fraction of the total societal cost of regulatory compliance in the OCS. In considering this fraction of the total cost, it is important to recognize that diversion of industry talent from development and production-related activities to regulatory work is likely more costly to society as a whole than to industry.

Data for this report were obtained in a survey of seven companies represented on the Executive Committee of the Offshore Operators Committee, which collectively operate approximately 55 percent of the active producing wells in the OCS. Data from these companies were plotted (man-years effort vs. wells operated) and extrapolated to obtain an estimate of the total regulatory compliance effort for the entire OCS. Basic findings of this survey are as follows:

- Some 3,200 man years of effort valued at $155 million were expended by industry during 1979 to obtain compliance to OCS regulations.

- This level of effort represents about 26 percent of the operators' work force engaged in OCS drilling, development, and production activities. In perspective, 3,200 man years/year is equivalent to the primary OCS work force of Exxon, Gulf, Shell, and Texaco, which collectively operate 33 percent of the active wells on the OCS and collectively drilled 22 percent of all new OCS wells during 1979.

- Stated another way, regulatory compliance requires 4 1/2 full time employees for each drilling rig and 6 full time employees for each 20 well production platform.

- Of this total effort, over half (56 percent) is estimated to be incremental effort excessive of the industry effort which would be required to operate prudently in the absence of regulation.

Comparison of regulatory compliance effort in the OCS to other regulatory regimes shows that:

- OCS regulatory compliance effort is about six times greater and nine times more costly than for similar activities conducted onshore.

- OCS regulatory compliance effort is approximately 40 times more costly than the average for 48 companies (20 industries) participating in the Business Roundtable Study for calendar year 1977.

A limited effort to identify societal benefits obtained from this intensive regulatory effort reveals the following:

- Oil spilled from OCS drilling and producing operations during the period 1972-1978 (about 1,150 barrels out of the total annual spillage from all sources in U.S. waters of about 375,000 barrels) has improved an average of 8 barrels per year over the period. Incremental industry personnel costs for regulatory compliance effort is approximately $56 million per year.

- Comparisons between drilling operations conducted in state-owned waters offshore Louisiana and those conducted in the OCS show fewer blowouts per 100 new wells started in state waters which are governed by less severe regulations than in the stringently regulated OCS.

Conclusions

The cost of regulatory compliance for oil and gas extraction activities on the OCS is excessive when judged by any reasonable yardstick.

The benefits of the intensive regulatory effort to society are not apparent. There is little evidence to support the need for intensive regulation of OCS activities and less evidence to suggest that the present regulatory regime is effective in improving the quality of OCS operations.

Substantial reform of the OCS regulatory structure is needed to provide responsible and beneficial regulation of the OCS activities at a reasonable cost to industry and society.

Societal Cost of Regulation

There is a tendency among laymen, lawmakers, and regulators to think of the cost of regulation only in terms of those costs borne by the industry being regulated. However, in addition to direct costs to the regulated company, regulatory costs also include the cost of government implementation and enforcement of the regulations (including involvement of the federal, state and local sectors); the cost of participating private groups or citizens; and finally, and perhaps most importantly, the cost borne by the general public, in terms of the regulatory impact on product supply, product costs, the economic climate of the nation and the life-style of the average citizen.

Obviously, the determination of the total cost of regulations is very complex and would require data and economic analysis well beyond the scope of this study. This study attempts to make a substantive comment concerning the direct cost to industry of certain portions of regulatory compliance and some of the elements of the cost of government associated with these regulations. Based on the data presented, it is hoped that some inferences may be drawn relative to the total costs and benefits to the public.

While the societal cost of regulatory compliance is almost inextricably interwoven into the fabric of the society and the total cost can seldom be quantified except in broad sweeping generalizations, some elements of the total cost are reasonably quantifiable. These include portions of the cost of regulatory compliance to industry and the cost of government associated with the regulatory activity. The elements of these costs are discussed below.

Cost to Industry

The cost of regulatory compliance to industry may be roughly divided into two categories. These are the direct cost associated with complying with regulatory requirements and the indirect cost resulting from alteration of business opportunities due to regulations.

- Direct Cost to Industry. Direct cost to industry includes both expenditures for an operator's own account, and costs borne by contractors and suppliers which are passed on to the operator in the form of increased charges for materials and services. Categories of costs are similar in both instances. The following categories of costs and expenses need be considered in determining the direct cost of regulatory compliance.

- Capital Expenditures. Regulations frequently mandate the installation of certain equipment or the establishment of certain processes in order to obtain compliance with the regulatory objective. Capital expenditures include the cost of purchase, and installation of such equipment including the cost of operator's personnel necessary to design and supervise the purchase and installation of the equipment, as well as attendant contractor services.

- Operating Costs. Operating costs include materials, personnel, and transportation necessary to operate and maintain the equipment mandated by regulation. Also included are personnel, materials, and contract services necessary to perform tests, laboratory work, etc., mandated by regulation, and to prepare periodic reports required by the governing agency.

- Administrative Costs. Administrative costs are primarily personnel costs associated with obtaining needed permits and assuring that field operations remain in compliance with regulatory mandates. Such costs include as well the expense of maintaining staff with the necessary expertise to interpret new regulatory proposals and to detail for field locations those actions necessary to obtain regulatory compliance.

- Technical or Administrative Support. This category of cost includes consulting services both internal and contractor which frequently must be obtained to successfully interpret and administer regulations when the demand for expertise exceeds the capability of the unit being regulated.

- Research and Development Costs. Regulations frequently demand performance exceeding or approaching the leading edge of currently available technology. Research is necessary to develop systems or procedures which will obtain regulatory compliance, or to develop new systems or procedures which will be more efficient and less costly.

- Litigation Costs. Litigation arises in many forms relative to OCS activities. Almost all lease sales in frontier areas have been challenged by third parties, and the industry has intervened in such litigation to assist in obtaining lease sales. Litigation costs also are incurred relative to challenges of regulatory or permitting requirements.

Indirect Cost to Industry. Indirect costs are more difficult to quantify than direct costs. Items included in this category include costs incurred through delay of projects by regulatory constraints (such as permitting difficulties), loss of opportunity because of regulatory exclusion, shortages of key personnel because of regulatory compliance demands upon the organization, and general loss of productivity of an industrial organization resulting from confusion, personnel shortages, etc., stemming from regulatory activities.

Cost of Government

The Outer Continental Shelf is a federal domain, thus, the cost of governing regulatory activities primarily relates to the federal agencies. However, because of recent legislation and the intense interest in OCS oil and gas activities by coastal states, many states and local communities have extensive staff and expenses relative to OCS regulatory activities.

Cost of government also may be divided into direct costs and indirect costs. Capital costs are incurred with a purchase of vehicles, helicopters and vessels necessary to inspect OCS operations and to enforce regulatory mandates. Operating costs include those incurred for the housing and support of the numerous personnel of multiple agencies, state and federal, that are involved in regulating the Outer Continental Shelf. Administrative and support costs are incurred by government in the processing of permit applications, and in sorting and handling reports and data required by regulations. In addition, significant research and development expenditures are made by governments to obtain independent viewpoints concerning the technical feasibility of new processes, to obtain an independently derived data bank, and to obtain independent studies from consultants and contractors which will aid the regulatory agency in performing its function. Extensive expense also is incurred by government, particularly the federal government, in litigation expense, both in defending agency actions, regulations or policies, and in enforcement proceedings against individual operators within the industry.

Indirect costs associated with the cost of government include the loss of national productivity resulting from burdensome regulatory requirements which reduce the competitive position of the nation relative to the world markets, the diversion of critical talents from the industrial sector to the government sector (which is generally necessary to successfully administer regulations of a technical nature) and inflationary pressures resulting from imposing nonproductive work on the industrial sector. These costs are seldom measurable because of the complex interaction of various economic factors affecting the economic health of a society.

The Cost of Regulatory Compliance Survey - OCS Oil and Gas Industry

As indicated by the foregoing discussion, the problem of determining the total cost of regulatory compliance is exceedingly complex and unlikely to be reliably quantified. Thus, in the early consideration of this problem a decision was reached to limit the study to an effort to determine direct cost to industry and government. With this limited scope a decision was made to confine the study to the elements of regulatory costs of most significance.

Discussions with representatives of companies serving on the Executive Committee of the Offshore Operators Committee developed the consensus that the single most important impact of regulations on the

OCS industry is the diversion of technical talent and operating manpower from normal activities to regulatory compliance activities. For these reasons, the decision was made to limit the survey of the cost of regulatory compliance to those items affecting personnel and the cost of those personnel. It was further agreed that the usurpation of the talent was a more important consideration than the expense of maintaining these personnel. The identification of the talents involved in regulatory compliance also was considered to be a useful outcome of the study.

Seven companies who collectively operate 55 percent of the wells in the Outer Continental Shelf agreed to participate in the survey. These companies are, in alphabetical order, Amoco, Chevron, Conoco, Exxon, Gulf, Shell, and Texaco. As a condition for their participation, it was further agreed that data obtained from an individual company would
not be identified as to its source.

A form was developed to collect data from companies participating in the survey. The form provides for recording divisions of talent included technical professionals and managers, operating staff, technicians, hourly employees and other. The latter category including accountants, attorneys, purchasing agents, clerks, administrative and support personnel, etc. The form also allowed distribution of time among the following categories: exploratory drilling, development, and production and remedial activities. A further subdivision also allowed distribution of time in these categories among planning activities, execution activities, and regulatory compliance activities.

In the determination f expense or the cost of personnel involvements, it was agreed that the pay scale among the various companies would be sufficiently comparable that the determination of average cost per employee by a single company would suffice for the study. Items included in expense include salary and benefits to the individual, office space requirements, food and quarters (offshore) and transportation (offshore).

Guidelines to Participants

The following guidelines were developed to assist the participating companies in obtaining and categorizing data on manpower expended toward regulatory compliance.

- Time and effort required to respond to or adhere to all regulatory requirements affecting post sale OCS drilling, development, and production operations would be included.

- No effort would be made to adjust data for "good practices" (actions that the operator would have employed in the absence of the regulation).

- Data would be based on calendar year 1979 or the current level of effort and expressed in man-years per year and percent of work force.

- Data would be subdivided into the following wo. groups: technical professionals (including managers), operating staff and technicians, hourly employees (field locations), others.

- All participating companies would collect data for organizational Level I--Project Generation and Execution (this level is called a district or division in most companies).

- Company A would additionally collect data from all affected organizational levels, provide cost parameters and, from internal data, provide a model for more detailed time allocation. Company A also was to collect comparative data for onshore operations.

- Company B would additionally collect comparative data for its onshore operations and organizational Level II.[1]

Survey Results

Data Base

Data obtained from five of the seven participating companies were essentially complete with the exception that only three of the five companies elected to divide their regulatory effort into the activity categories of exploratory drilling, development drilling and production. Data from the remaining two companies was useful in the survey in determining total regulatory compliance effort but did not adequately allocate the manpower expenditures among the different talent groups.

Methods of data collection within individual companies varied as it was agreed that the data should be collected expeditiously with the minimum effort necessary to obtain a reliable estimate. Two of the seven companies participating had previously established mechanisms from which to obtain their data base. The remaining five companies obtained their data by interviewing individuals, supervisors, or managers as appropriate, to obtain a reliable estimate. Although the data obtained are not subject to rigorous audit or review and cannot be considered to be precise, the uniformity and relative consistency among the companies lend credibility to a conclusion that the data obtained do indeed represent a reliable estimate. Figures 1-7 permit a subjective examination of the data from the individual companies.

Level 1

Regulatory Compliance Effort
By
Job Classification
Percent Of Total Work Effort

Job Classification	Percent of Total Work Effort CO.A	CO.B	CO.C	CO.D	CO.E	CO.F	CO.G	AVERAGE
Technical Prof.	21	7	32	22	37	18	25	16.3
Technician	27	-	21	-	42	14	-	4.9
Operations-Staff	40	14	20	19	42	-	-	17.5
Operations-Hourly	37	23	26	30	-	-	-	46.6
Others	31	8	24	30	26	14	-	14.7
Total	34	17	25	26	32	15	-	100

FIGURE 1

Level 1

Regulatory Compliance Effort
By
Job Classification Man Years/Year

Job Classification	Man/Years/Year CO.A	CO.B	CO.C	CO.D	CO.E	CO.F	CO.G	PERCENT
Technical Prof.	27.5	8	19	57	34	15	51	16.3
Technician	23.4	-	12	-	7.6	10.5	10*	4.9
Operations-Staff	55.3	24	25	32	53	-	37*	17.5
Operations-Hourly	223.5	93	64	123	-	-	100*	46.6
Other	14.7	8	16	18	78	23.5	32*	14.7
Total	344.4	133	136	230	172.6	49	230*	100

*Estimated

FIGURE 2

Level 1

Regulatory Compliance Effort
By
Activity Man Years/Year

Activity	CO.A	CO.B	CO.C.	CO.D	CO.E	CO.F	CO.G	Percent
	Man Years/Year							
Exploratory Drilling	13.4	-	9.0	-	-	3.2	-	4.8
Development	57.5	-	17.5	-	-	9.5	-	16
Production	273.5	-	109.5	-	-	36.3	-	79.2
Total	344.4	133	136	230	172.6	49	230	100

FIGURE 3

Regulatory Compliance Effort
By
Organizational Level

	Company					
	A		B		Total A & B	
	MY/Y	%	MY/Y	%	MY/Y	AVG. %
Level I						
Project Generation and Execution	344	78.2	133	73.5	477	76.8
Level II						
Functional Administration and Direct Support	72	16.4	36	19.9	108	17.4
Level III						
Corporate Administration and Centralized Support	24+	5.4	12+ (EST.)	6.6	36	5.8
Total	440	100.0	181	100.0	621	100.0

FIGURE 4

Company A - Offshore Division
Manpower Commitments - OCS Compliance

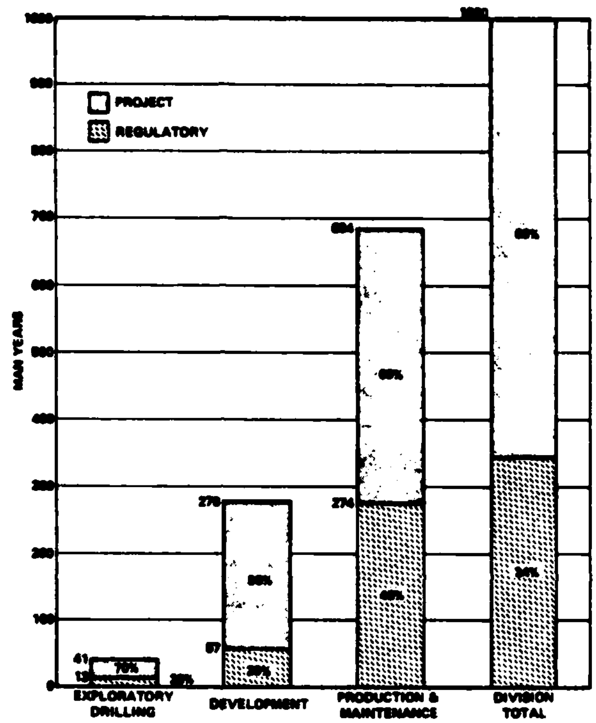


FIGURE 5

Company A - Offshore Division
Manpower Commitments OCS Regulatory Compliance

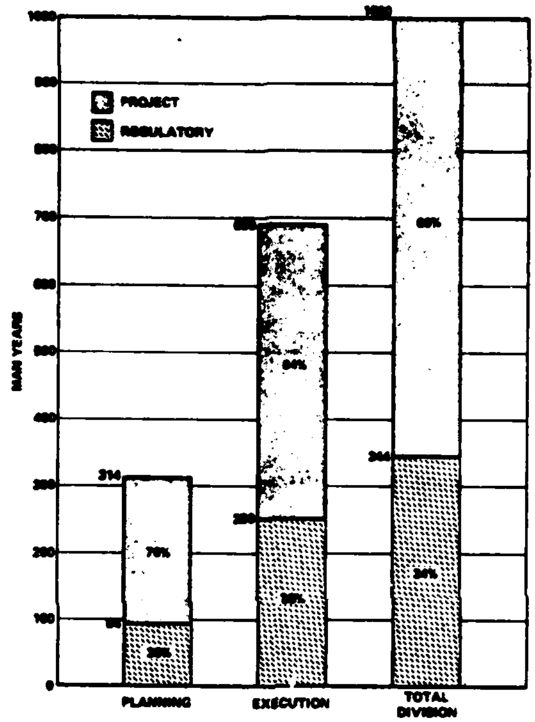


FIGURE 6

Company A - Offshore Division
Manpower Distribution

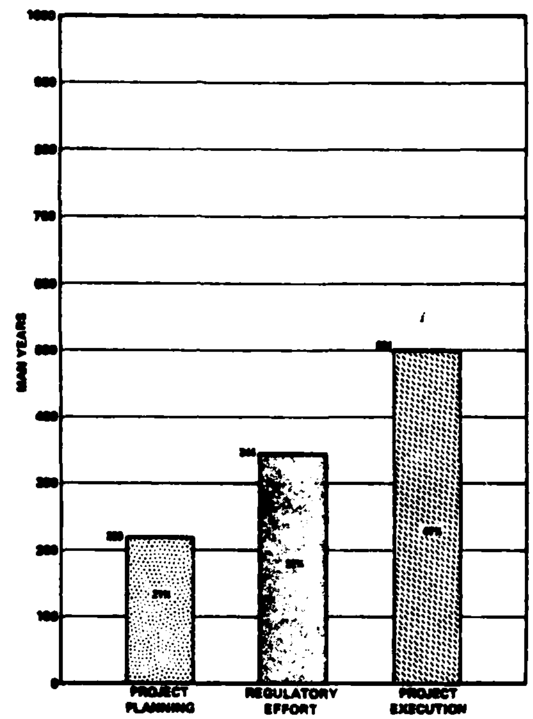


FIGURE 7

Extrapolation of Results

As the data obtained from the seven participating companies represent only about one-half of the production from OCS operations, a method was necessary by which the data could be indexed and extrapolated to obtain an estimated for the total OCS. A number of possible indices were considered, including production rate, leasehold on the Outer Continental Shelf, and number of wells operated. A consensus developed among the participants that regulatory burden in the OCS is most strongly related to the number of wells operated, with a marginal well requiring equal regulatory effort to a high volume producer. Thus, regulatory effort (man-years per year) was indexed against the number of wells operated. Figures 8 and 9 show the resulting plot of cumulative man-years of regulating compliance effort compared to cumulative number of wells operated.

The data plot in Figure 8 indicates that regulatory manpower expenditures at Organizational Level I for 50 percent of the wells on the OCS amounts to 1,180 man-year per year. Extrapolation to 100 percent of OCS wells yields 2,360 man-years per year for Level I Organizations. Based on a survey within Company A, it was determined that the average expense for each man-year of effort is approximately $48,500 per year. On this basis, the cost of a regulatory compliance effort of 2,360 man-years is equivalent to $114 million per year.

Figure 9 illustrates the additional regulatory effort at organizational Levels II and III. Extrapolation of this plot yields a total regulatory effort for calendar year 1979 of approximately 3,200 man-years per year for all oil and gas operation in the Outer Continental Shelf. The cost of this effort is estimated to be $155 million.

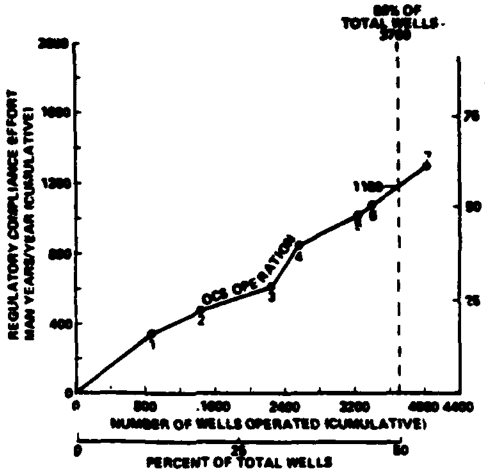
The data may also be presented in various forms corresponding with the format used for collection. The percentage breakdowns, and total work effort in various categories are shown in Table 1.

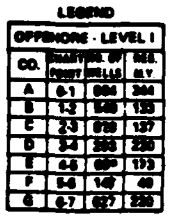
The data may also be examined and distributed on the basis of units of activity (Table 1). Table 2 shows a breakdown of the regulatory effort per active drilling rig and the regulatory effort per active production platform including the distribution of talents involved in each activity.

Significance of Survey Results

For the reader unfamiliar with OCS operations, the individual breakdowns and categorizations of manpower expenditures toward regulatory compliance may lack meaning in the absence of an external yardstick with which to make comparison. Comparisons of the OCS regulatory compliance effort to the nature and magnitude of the problems being addressed, to other industrial activities and to similar oil and gas activities in other environments are needed to provide perspective. Perhaps the first step in creating this understanding is to examine the nature of the concerns addressed in the regulatory process.

ORGANIZATIONAL LEVEL I



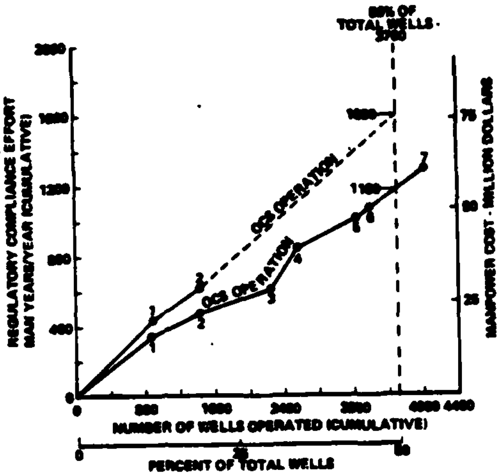


NOTE:

1. Projection of Offshore Level I to 100% of Total Wells = 2360 M.Y. or $114 Million

FIGURE 8

ORGANIZATIONAL LEVEL I
+II +III



LEGEND

OFFSHORE - LEVEL I				[illegible]
CO.	[illegible]	[illegible]	[illegible] M.Y.	[illegible] M.Y.
A	0-1	[illegible]	244	[illegible]
B	1-2	[illegible]	[illegible]	161
C	2-3	[illegible]	137	
D	3-4	[illegible]	[illegible]	
E	4-5	[illegible]	173	
F	5-6	147	[illegible]	
G	6-7	[illegible]	[illegible]	

NOTE:

1. Projection of Offshore Level I to 100% of Total Wells = 2360 M.Y. or $114 Million

2. Projection of Offshore Levels I & II & III to 100% of Total Wells = 3200 M.Y. or 155 Million

FIGURE 9

TABLE 1

Regulatory Compliance Effort by Activity
(Organizational Level 1)
(Based on Data from Three Companies)

Activity	Percent of Total Effort
Exploratory Drilling	4.8
Development	16.0
Production	79.2
Total	100.0

Regulatory Compliance Effort by Job Classification
(Organizational Level 1)
(Seven Companies Participating)

Job Classification	Percent of Total Effort
Technical Professionals	16.3
Operations - Staff and Technicians	22.4
Operations - Hourly	46.6
Other	14.7
Total	100.0

TABLE 2

Regulatory Compliance Effort
Exploration and Development
Company A
Regulatory Effort Per Drill Rig

Job Classification	Reg. Effort Man Years	Reg. Man Years (1) Per Drilling Rig	Cost of (2) Personnel
Tech Prof.	15.4	.96	
Technician	13.6	.85	
Operation-Staff	25	1.57	
Operation-Hourly	13	.81	
Others	3.9	.24	
Total	70.9	4.43	$214,642
Rigs			(1) 16 Act. (2) $48,452/MY

Production and Maintenance
Company A
Regulatory Effort and Production Platform

Job Classification	Reg. Effort Man Years	Reg. Man Years (1) Per Prod. Platform	Cost of (2) Personnel
Tech. Prof.	12.1	.27	
Technician	9.8	.22	
Operations-Staff	30.3	.67	
Operations-Hourly	210.5	4.65	
Others	10.8	.24	
Total	273.5	6.05	$293,134

(1) 20 Wells/ Plt.
(2) $48,452/MY

Societal Concerns Regarding OCS Operations

Regulations governing OCS activities are pervasive and address virtually every aspect of operational and business decisions. Despite the wide scope of the regulatory base, the preponderance of the regulatory effort addresses elements of safety and pollution prevention, primarily the prevention of blowouts and oil spills. Although no attempt was made during the survey to determine directly the proportion of regulatory effort directed toward these activities, experience suggests that 80 percent is a reasonable estimate. What is the nature and magnitude of the problem addressed by this effort?

According to data collected by the U.S. Coast Guard and the U.S. Geological Survey during the period 1971 through 1977, an average of some 375,000 barrels of oil are spilled in U.S. waters each year. In OCS drilling and production operations, an average of approximately 1,150 barrels of oil have been spilled per year, for the period 1972-1978. This amounts to 3/10 of 1 percent of the total oil spilled in U.S. waters.

Data published by the USGS for the period 1971 through 1978 show that of 7,553 new wells started during that time span, some 30 wells (4/10 of 1 percent) suffered loss of control (i.e., blew out) for a period of time ranging from 15 minutes to a maximum of 21 days. None of the wells over which control was lost caused oil pollution, as all "blow-outs" resulted from the penetration of either shallow or deep high pressure gas zones. The average period of uncontrolled flow for 29 of the 30 wells was slightly over three days. (The 30th well was reported to have bubbled gas for a period of approximately three months, thus, is difficult to evaluate.) The record further shows that in all of the exploratory drilling which has occurred on the Outer Continental Shelf, there has never been an oil spill exceeding 50 barrels. Further, in all of the drilling, development, and production activities which have occurred in federal and state offshore waters (more than 23,000 wells had been drilled as of January 1, 1979), only the Santa Barbara incident of 1969 has significantly affected a coastal area. During the period 1971-1978, the greatest amount of oil spilled as a result of an uncontrolled well flow was 450 barrels. This event occurred when an explosion of an oil pump destroyed an offshore platform. During the period of review, a total of 8,000 barrels of oil were spilled by OCS drilling and producing operations. While some 2,410,000,000 barrels of oil were produced, a spillage rate of only 3.3 barrels of oil spilled for each 1 million barrels of oil produced. The reader is invited to consider whether this operating record is of sufficient concern to society to justify the large expenditures of industry manpower necessary to comply with existing regulations.

Comparison to Other Regulatory Regimes

The foregoing discussion provides the reader some knowledge as to the nature of the concerns being addressed by regulation in the Outer Continental Shelf and may enable some subjective judgement as to whether the degree of regulation and regulatory costs are justified based on the nature and magnitude of these concerns. However, in today' society in which all industrial activities are extensively regulated, comparison to regulatory effort for other industrial activities is desirable to obtain a more objective viewpoint of the regulatory effort demanded in the OCS. To obtain this objective comparison, two separate approaches have been utilized. First, data were collected for regulatory compliance effort in onshore oil and gas operations by two of the seven companies participating in the Cost of Regulatory Compliance Survey. Second, the data obtained for OCS operations are compared to data obtained from a recent study conducted under the auspices of the Business Roundtable. This letter study for calendar year 1977, included extensive data from 48 major manufacturing companies in the United States. A discussion of these two comparison follows.

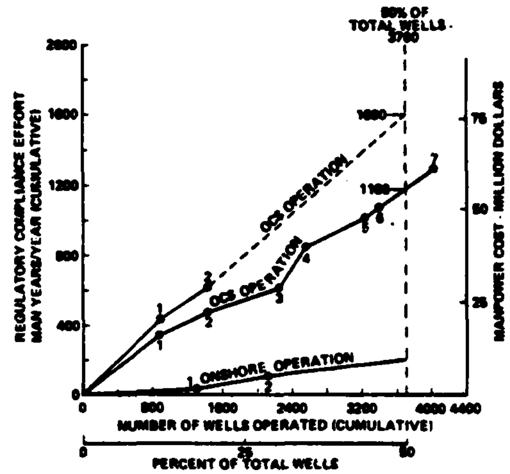
Comparison to Onshore Oil and Gas Operations

During the Cost of Regulatory Compliance Survey, two of the seven participating companies collected data for onshore oerations as a means of establishing a comparative data base. Data obtained were limited to drilling and producing operations for onshore oil and gas activities, thus, are comparable to OCS data. By way of explanation, onshore oil and gas operations are similar in every respect to offshore oil and gas operations except for the environment in which the activity is conducted. Although the working environment is admittedly more difficult offshore, the risks and environmental and social concerns inherent to the onshore operation frequently exceed those attendant to offshore operations in that economics permit the drilling of deeper, more difficult more highly pressured wells onshore. Such operations are often conducted in proximity to dwellings, public roadways or other public facilities and private, rather than public, property rights are involved. Regulatory regimes differ in that state and local governments regulate onshore oil and gas operations with the exception of regulations emanating from the Environmental Protection Agency and the Occupational Safety and Health Administration. Conversely, in the offshore regime, most regulations emanate from federal agencies except for state and local government requirements emanating from the Coastal Zone Management Act.

Figures 10 and 11 illustrate the comparison of regulatory effort in the onshore and offshore regimes.

The data presented here show that for an onshore equivalent of the 7,400 well now active in the Outer Continental Shelf, some 400 man-years of effort would be expended annually toward regulatory compliance at organizational Level I. This compares to some 2,360 man-years of effort expended for offshore operations. Thus, for an equivalent level of operation approximately six times as much effort toward regulatory compliance is required in the offshore regime as in

ORGANIZATIONAL LEVEL I
+II +III
ONSHORE OPERATIONAL LEVEL I



LEGEND

OFFSHORE - LEVEL I				LVL. II & III	ONSHORE LEVEL I	
CO.	CHART POINT	NO. OF WELLS	REG. M.Y.	REG. M.Y.	NO OF WELLS	REG M.Y.
A	0-1	[illegible]	344	440	[illegible]	36
B	1-2	[illegible]	133	161	815	67
C	2-3	828	137			
D	3-4	[illegible]	230			
E	4-5	[illegible]	173			
F	5-6	[illegible]	40			
G	6-7	[illegible]	230			

NOTE:

1. Projection of Offshore Level I to 100% of Total Wells = 2360 M.Y. or $114 Million

2. Projection of Offshore Levels I & II & III to 100% of Total Wells = 3200 M.Y. or $155 Million

3. Projection of Onshore Level I to 100% of Wells = 400 M.Y.

FIGURE 10

Comparative Cost of Regulatory Compliance
Organization Level I
Personnel Costs

OCS Drilling and Producing Operations
vs.
Onshore Drilling and Producing Operations

	MY/Y	SM
Total OCS (7,400 Wells)	2,360	114,000
Equivalent Onshore (7,400 Wells)	400	13,000
Difference	1,960	101,000
Ratio OCS: Onshore	5.9:1	8.8:1

FIGURE 11

the onshore regime. The ratio of cost for personnel involved in regulatory compliance is approximately nine times greater in the offshore regime than in the onshore regime. The average cost per man-years effort in the onshore regime is $32,954 compared to $48,452 in the offshore regime.

Comparison to the Business Roundtable Study

The Cost of Regulation Study for the Business Roundtable was published in March 1979. The study was conducted by Arthur Andersen and Company for the Business Roundtable and included a study of the direct incremental cost incurred by 48 companies in complying with the regulations of six federal agencies for calendar year 1977. The 48 participating companies operate in more than 20 industries and are all large corporations. Regulatory requirements of the following six federal agencies were considered in the study: The Environmental Protection Agency (EPA), Equal Employment Opportunity (EEO), Occupational Safety and Health Administration (OSHA), Department of Energy (DOE), Employee Retirement Income Security Act (ERISA), and the Federal Trade Commission (FTC). The study developed "incremental" costs of regulatory compliance for the six aforementioned agencies. In this context "incremental" costs are those costs for regulatory compliance in excess of costs that the company would normally have incurred in the absence of the regulation. Determination of incremental cost thus requires subjective judgement by each company as to the manner in which their operations would have been conducted in the absence of the regulatory framework.

Because the Business Roundtable Study's expression of regulatory compliance costs is in incremental terms and the expression of the OCS cost of regulatory compliance survey is in total regulatory costs, additional work was necessary to make an adequate comparison between the data generated by the two studies. To obtain data for comparison, one of the seven companies participating in the cost of regulatory compliance survey was asked to make additional studies to obtain an estimate of the portion of the total compliance costs in the OCS excessive to their "normal" mode of operation. The "normal" mode of operation would include the highest degree of social responsibility and emphasis on safety of operation even though regulatory mandates were absent. Federal agencies considered in the offshore regulatory costs would include EPA, OSHA, EEO, DOE, and FTC which were a part of the Business Roundtable Study; and in addition USGS, U.S. Coast Guard and the U.S. Corps of Engineers which are primary regulators in the Outer Continental Shelf.

As the cost of regulatory compliance survey for the OCS includes only the direct cost of <u>personnel</u> involved in regulatory compliance and the Business Roundtable Study includes <u>total</u> incremental direct cost, it was necessary to extract personnel costs from the Business Roundtable Study to enable comparison. For this purpose, the category of cost title Operating and Administrative and Research and

Development Costs Sources was extracted from the Business Roundtable Study. Discussing these costs, page 16 of the report reads as follows: "This amount ($532 million) represents an average incremental labor cost of $164 per employee for these companies, and addition of nearly 1 percent of the average wage cost, including fringe benefits."

Data from OCS operations comparable to the Business Roundtable Study, are shown in Figure 12.

In summary, the best available comparison between the Business Roundtable Study and the Cost of Regulatory Compliance Survey for the OCS indicates that labor or personnel cost for regulatory compliance in the OCS (at $7,078 per employee) exceed equivalent industry cost for the 48 companies participating in the Business Roundtable Survey (at $164 per employee) approximately 40 times.[2] To further illustrate the magnitude of this differential, the OCS regulatory cost per employee of the corporation (e.g., including all employees in the manufacturing, chemical, mining, etc., who have no responsibility for the OCS) is about $215 per employee compared to the Business Roundtable cost of $164.

Effectiveness of OCS Regulations

The prior sections of this report have described the societal concerns which led to regulation of OCS activities, and have examined the cost to industry of personnel involved in regulatory compliance. The questions which remain center on the benefits which are being derived from this large regulatory effort. How successful are the regulations in achieving intended goals? Is there demonstrable improvement in industry performance as a result of these regulations?

Two yardsticks may be used to judge the effectiveness of the regulatory regime. First, comparison may be made between the performance of the industry in similar operating environments in which the regulatory regime differs from that in the OCS. Second, one may compare the performance of the industry over time against the regulatory structure that has been imposed upon its operations.

As prevously stated, all facets of OCS operations are regulated. Thus, it would be possible to attempt to compare several areas of performance to attempt to obtain a measure of the effectiveness of the regulatory regime. However, since the consensus of industry and the regulating agencies is that the bulk of the regulatory activity is directed toward the safety of the OCS operation, this report will focus on that area.

In the context of safety, two elements are paramount. First, the prevention of oil spills and pollution; second, the prevention of blowouts. Although a precise measure of the effort expended toward safety regulatons cannot be obtained from the data collected in the survey, it is known that all effort at the operating level is directed toward safety and much of the effort by technical professional and other office staff are directed toward either operating safety or environmental considerations. Based on these observations, one may reasonably conclude that approximately 80 percent of the total effort

Comparative Cost of Regulatory Compliance
Personnel Costs Only

The Business Roundtable
Cost of Government Regulation Study
(Direct Incremental Costs for 48 Companies)
(EPA, OSHA, EEO, DOE, ERISA and FTC)

vs.

Oil Industry
(Drilling and Producing Operations)
(EPA, OSHA, EEO, DOE, FTC, USGS, USCG, COE)

	SMM		$/Employee	
	Total	Incremental	Total	Incremental
BRT-CORS Personnel Costs Only				
Operating and Administrative Labor (Incl. R&D)	-	532	-	164
Oil Industry Personnel Costs Only				
Equivalent Onshore - Total OCS				
Level I	13	-	1,964	-
Level I	114	64	12,608	7,708
Level I & II	155	101	11,620	7,572

FIGURE 12

is directed toward safety or environmental protection. Given this conclusion, the performance factors used for comparison to regulatory effectiveness should be those relating to pollution prevention and safety of the operation. In these areas of concern, the primary performance factors to be considered are oil spills originating from OCS operations, and blowouts occurring during either drilling or production operations. A discussion of these two performance parameters follows:

Industry Performance in Blowout Prevention on the OCS

Tabulated below are data obtained from the USGS showing "blowouts" occurring from both drilling and nondrilling operations during the period 1971 through 1978.[3] Also shown in the tabulation are new wells started each year and the percentage of these wells suffering loss of control.

Drilling Blowouts

Year	New Wells Started	Exploration	Development
1971	841	2	0
1972	847	2	1
1973	820	2	1
1974	816	0	1
1975	882	4	0
1976	1,041	1	4
1977	1,158	2	2
1978	1,148	4	4
	7,553	17	13

Nondrilling Blowouts

Year	Oil and Condensate Production (million bbls)	Production Number	Production Spillage (bbls)	Workover Number	Workover Spillage (bbls)	Completion Number	Completion Spillage (bbls)
1971	418.5	2	450	1	0	0	0
1972	411.9	0	0	0	0	0	0
1973	394.7	0	0	0	0	0	0
1974	360.6	2	75	1	200	0	0
1975	330.2	0	0	1	0	1	0
1976	316.9	1	0	0	0	0	0
1977	303.9	0	0	3	0	2	0
1978	292.3	0	0	2	some condensate	0	0

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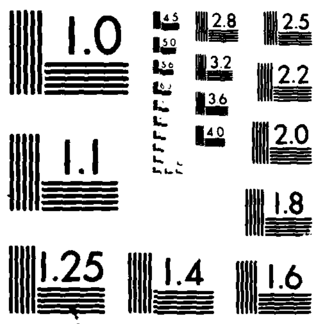


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

To the layman, the term "blowout" connotes a disaster which is greatly misleading for the majority of data presented here. A better description of these events is the phrase "incident of accidental loss of well control". For example, in 1978, the period of loss well control for the six incidents reported range from 15 minutes to a maximum of 72 hours, averaging approximately 22 hours per incident. Further, there was no pollution arising from any of the six incidents. During the entire period, from 1971 through 1978, no pollution resulted from any drilling incident and only five incidents occurred during the period where loss of well control exceeded five days. Also as stated in a prior section of this report, loss of well control exceeded five days. As stated in a prior section of this report, for the entire period from 1971 through 1978, only .4 of 1 percent of the wells drilled suffered some loss of control and the average period of loss of control was approximately three days.

The reader also is invited to observe, however, that the trend of data does not show evidence of improvement in blowout incidence rates despite the intensive regulatory effort that has been imposed upon the industry in recent years. As in the case of oil spill statistics, there is no direct evidence to suggest that regulations have succeeded in reducing the incidence of well blowouts.

Figures 13 and 14 show a comparison of blowout statistics for drilling operation in the OCS and in the State waters of Louisiana.[4] Also shown are new well starts in both the OCS and Louisiana State waters. Although there were significantly fewer well starts in State waters (approximately 100 per year vs. 800 per year in the OCS), sampling would be statistically significant. During the period where comparable data are available, 1973 through 1978, only one drilling blowout occurred in State waters compared to 18 in the OCS, or 1 well in 583 starts in State waters compared to 1 well for each 254 starts in federal waters.

The regulatory regime in Louisiana State waters is substantively different from that in the OCS with minimal effort required to comply with safety oriented regulations. The operations in the State waters of Louisiana would, for the most part, utilize similar equipment and similar techniques to those used in the OCS. However, the difficulty of the operation being conducted may differ significantly from operations in the OCS in that geological conditions are better known in State waters; fewer wildcats are drilled and many of the wells drilled in State waters would be routine in filling locations. Because of these differences, it is not possible to draw direct parallels between OCS operations and similar operations in State waters. However, the industry's performance in State waters is excellent and one may conclude that the imposition of the stringent regulatory requirements imposed on OCS operations would have little tangible benefit if applied to the moderately regulated State water operations. This fact brings into further question the effectiveness of the regulations now being applied in the OCS.

Blowouts During Drilling Operations
OCS vs. State Leases - Offshore Louisiana

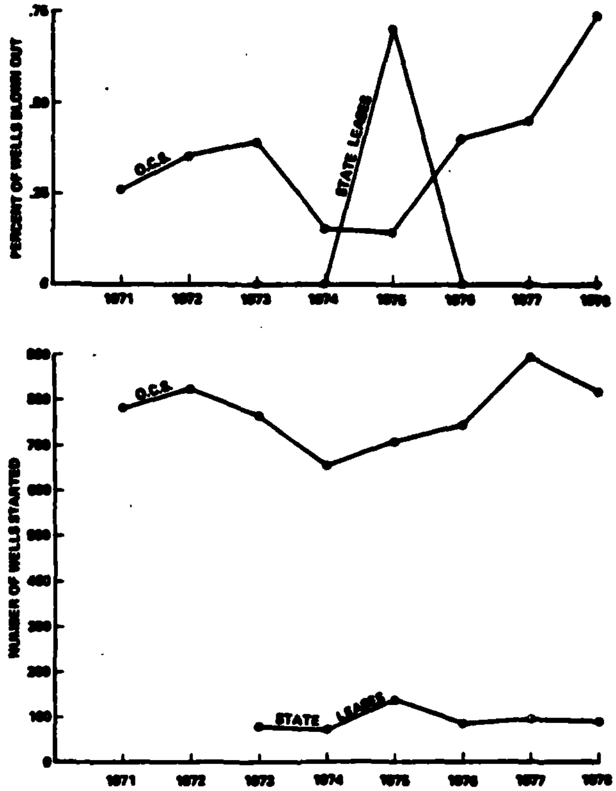


FIGURE 13

OCS Offshore Louisiana
State Leases - Offshore Louisiana

YEAR	NEW WELLS STARTED	BLOWOUTS				SPILLAGE BARRELS
		DRILLING	NON DRILL	TOTAL	% WELLS DRILL BLOWOUT	
1971	780 DATA NOT AVAILABLE	2 DATA NOT AVAILABLE	3	5	.26	445
1972	827 DATA NOT AVAILABLE	3 DATA NOT AVAILABLE	0	3	.36	0
1973	764 88	3 0	0 0	3 0	.39 0	0 0
1974	662 73	1 0	3 0	4 0	.15 0	275 0
1975	703 141	1 1	2 0	3 1	.14 .71	0 0
1976	743 86	3 0	1 0	4 0	.40 0	0 0
1977	883 98	4 0	5 0	9 0	.45 0	0 0
1978	816 95	6 0	2 1	8 1	.74 0	CONDENSATE 0
TOTAL	6177 593	23 1	16 1	39 2	.37 .17	720* 0

*No oil was discharged from drilling blowouts.

FIGURE 14

Oil Spills Originating from Drilling and Producing Operations. Oil spills originating from OCS operations include those resulting from blowouts, from accidental discharges during production operations, and those spills occurring during the transportation mode. However, transportation activities, either pipelining or surface transportation, are normally conducted by other organizations in the industry, thus, were not considered in the Cost of Regulatory Compliance Survey. To be compatible, oil spill data must be limited to those originating from production and drilling activities.

Data obtained from the USGS on oil spills originating from drilling and producing operations are shown in both tabular and graphical form on Figure 15. These data illustrate that for the period 1972 through 1978, OCS drilling and producing activities resulted in oil spills averaging about 1150 barrels per year. More importantly, these data illustrate that there has been no significant improvement in the oil spill performance of the OCS industry over that time span, despite the fact that the regulatory effort directed toward OCS activities during that period has increased exponentially.

Data presented in Figure 15 show that a maximum of 8 barrels of oil per year are saved from entering the environment by the regulatory effort. Incremental personnel costs for that regulatory effort are estimated to be approximately $56,000,000 per year.[5] Although the computations necessary to arrive at this cost per barrel of oil saved from the environment are imprecise, the order of magnitude of the costs is correct. The reader is invited to consider two questions. Has the regulatory regime imposed on the Outer Continental Shelf drilling and production activities significantly improved the performance of the industry in the prevention of oil spills? Is the effort toward regulatory compliance in oil spill prevention commensurate to the societal benefits obtained by this effort? In summary, is it worth the expenditure of $56,000,000 per year in personnel costs to prevent 8 barrels of oil from entering the marine environment?

Biographical information on O. J. Shirley is located on page 30.

INCREMENTAL REGULATORY COST OIL SPILL PREVENTION EFFORT	= $56 MILLION/YEAR
INCREMENTAL IMPROVEMENT IN OIL SPILLED	= 8 BBLS/YEAR
INCREMENTAL COST PER INCREMENTAL BARREL SAVED	= $ 7 MILLION

YEAR	BBLS. OIL SPILLED
1972	1182
1973	1161
1974	1342
1975	977
1976	1226
1977	1281
1978	820

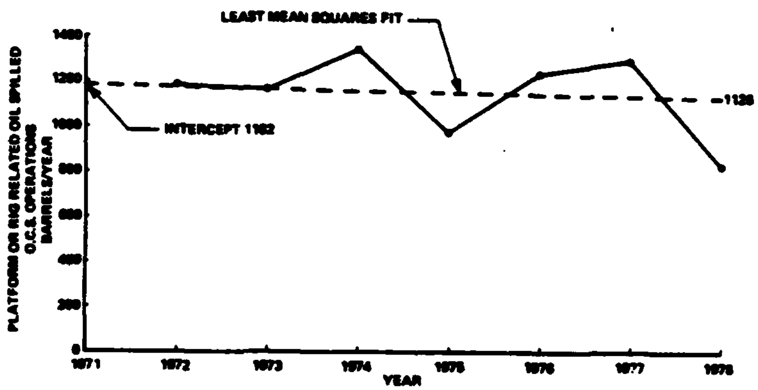


FIGURE 15

NOTES

1. No two oil companies are organized in precisely the same manner; however, most companies have a minimum of three tiers of management. For the purpose of this survey, primary focus was placed on the organization level within the company in which most technical staff are located and where operations are both planned and executed. Although different designations are given to this level by different companies (such as district, area, division, etc.), this organizational level is easily recognizable within most company structures. The Level II organization in most companies is an intermediate level between the operating levels and the headquarters of the company which generally has functional responsibility for several Level I operating units. In this survey, Level III would include all management and administrative personnel above the Level II organization.
2. To better understand this comparison, the reader is invited to make the following observations. The incremental costs of regulatory compliance are judged to be approximately 56 percent of the total cost by the one company undertaking further investigation. This fact is illustrated on Figure 13 by comparison of Level I cost totalling $12,608 per employee to Level I incremental cost of $7,078 per employee. These values were derived by dividing regulatory compliance costs incurred at Level I by the number of employees operating at Level I. Incremental costs for Level I and Level II ($7,572 per employee) were similarly derived. This method differs only in scope from that of the Business Roundtable Study where the total cost to corporations was divided by the total number of employees in the corporations.
3. "Outer Continental Shelf Oil and Gas Blowouts," U.S. Geological Survey, Open-File Report 80-101, Reston, Va., 1980.
4. Data on blowouts occurring in State waters were obtained from the Louisiana Department of Natural Resources.
5. Personnel costs for regulatory compliance directed toward the prevention of oil spills are not directly ascertainable from the data collected. However, assumptions may be made which will allow a reasonable estimate of these costs. As has been previously estimated, 80 percent of the total regulatory compliance effort is directed toward pollution prevention and safety. Data collected in the cost of regulatory compliance survey showed that 80 percent of this effort is expended during production activities and prevention and blowout prevention would be to assume that all effort in production activities is directed toward oil spill prevention and all effort in drillling activities is directed

toward blowout prevention. Thus, some 64 percent (i.e., .80 x .80) is directed toward oil spill prevention, with 16 percent (i.e., .80 x .20) being directed toward blowout prevention. On this basis, 64 percent of the $155,000,000 expended annually for personnel costs directed toward regulatory compliance, or $99 million is directed toward oil spill prevention. Incremental regulatory personnel costs directed toward oil spill prevention (that is, costs in excess of what companies would voluntarily expend) would be 56 percent of the total cost or approximately $56,000,000 per year.

SOME ENVIRONMENTAL CONCERNS IN OCS DEVELOPMENT

by

Michael E. Bender

Introduction

Few subjects dealing with the environment have stirred more controversy, both in the public and scientific communities, than appraisals of the potential ecological effects of oil spills or oil related developments. I believe that most of these disputes have developed because of: 1) the lack of data concerning the actual effects of offshore oil development, and 2) distortions or unwarranted conclusions drawn on the data which are available by both industry, environmentalists and the press.

I will attempt in this short review to provide a general background against which the adequacy of the available information on environmental effects can be judged. It should be noted at the outset, however, that our knowledge of chronic effects is very meager and even less is known about the specific causes of those effects which have been documented. Judgments regarding both the potential for effects and the importance of those effects must therefore be made. As our knowledge increases, we must revise our opinions and make appropriate changes in those regulations which are directed at lessening those effects deemed significant.

Ecological changes resulting from offshore oil development can be brought about by a wide variety of activities. Modifications resulting from structural alterations necessary for drilling, production and transmission of produced product will not be considered in this review. These effects are usually short lived, except of course for those related to the presence of the platform and/or pipelines themselves.

Major environmental concerns in the drilling phase of offshore development are: 1) the fate and potential effects of drilling muds and 2) the potential danger resulting from uncontrolled releases of petroleum. In both of these areas we must consider acute and chronic effects. Acute effects are those which are short-lived, but may for example, as is the case in damage to bird populations, have longer term implications. Acute effects brought about by the release of drilling muds would be the physical smothering of benthic organisms. Chronic effects might result from toxic compounds which would prevent recolonization or result in the contamination of recolonizing biota. Damage from spilled oil could result in both acute and/or chronic effects dependent upon the quantity, toxicity and fate of the spilled oil.

In most ecological studies, the demonstration of effects resulting from an activity is usually more easily accomplished than determining the specific cause of the effect. With regard to the oil industry, the determination of causal relationships is even more complicated since so many different activities are involved. A similar statement can be made with respect to the determination of the actual causes of effects resulting from spilled oil or chronic discharges, since so many different compounds are involved. Although in the case of spills, we do know that certain components of these releases are more toxic and persistent than others.

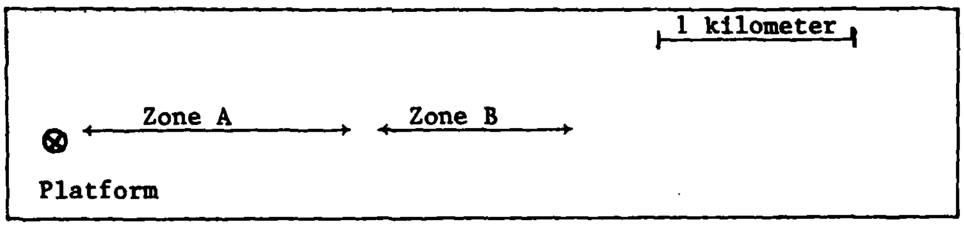
To further complicate matters, someone, we in this case, must make a determination a to whether an effect is ecologically significant enough to warrant the imposition of control measures, or to determine whether those regulations already in effect are appropriate.

Given sufficient cause vs. effect data together with the values for harvestable resources, such determination can be made, at least on an economic basis. However, we have no sound ecological protocols (although some legal basis have been developed) to assess damage on those populations of organisms which have no direct economic importance to man.

Potential Ecological Impacts

As potential impacts which might be related to oil development, please consider the following examples:

Example A - Effects on and Contamination of Harvestable Resources



Zone A - Clam and oyster populations reduced in abundance by 50 percent compared to control areas and tainted so that they must be depurated for one month prior to sale. Result - Value of harvest per year reduced by 1/2 in addition to an increased cost to market of 30 percent due to depuration.

Zone B - Populations undiminished in size but must be depurated.

Economics - Harvest area Zone A @ 5000 ha. and at 10 bu./ha. (control) vs 5 bu./ha. (Zone A) @ $15.00/bu = $750,000 vs $375,000 (Zone A) 750,000 - 375,000 - 112,500 depuration cost. Harvest = 262,500 vs control a loss of $487,500/year for Zone A For

Zone B @ 1900 ha. 10 bu./ha. @ $15.00/bu. = $285,000 - 30 percent for depuration (85,500) = 199,500 a loss of $85,500. An economic loss of $573,000 per year because of oil production activities.

Example B - Contamination of Harvestable Resources

Contamination in both zones results in residues which make the resource unharvestable because the residue does not depurate in a reasonable time, resulting in a complete loss of the resource.

Economics - Potential harvest from Zones A and B @ 15.00/bu = a loss of $935,000 per year because of the contamination. An economic loss of $935,000 per year because of oil production activities.

Examples C-F - Consider Impacts on Species Diversity and Biomass of Benthic Animals.

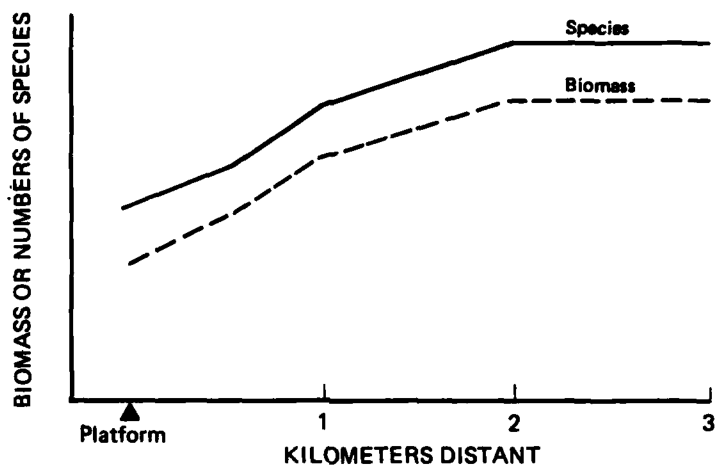
For each example, a graph showing the number of species and biomass of benthic animals vs distance from a platform has been prepared. Example C presents the classic pattern observed for toxic pollution, i.e., a simultaneous reduction in both species numbers and biomass. Example D shows the pattern of a reduction in sensitive species and their replacement by others to compensate, so that the quantity of food organisms available to higher trophic levels has not changed. In Example E, certain species have been stimulated either by additional food supplies or lack of predation, while those most sensitive to a pollutant still show a decline. Example F shows an increase in biomass near the platform, possibly because of surface effects or nutrients with no reduction in species numbers due to toxic wastes.

The examples shown above describe most of the possible effects on benthic animals which could result from the drilling and production activities of offshore oil operations. Unfortunately, few studies to determine whether these effects actually occur have been conducted.

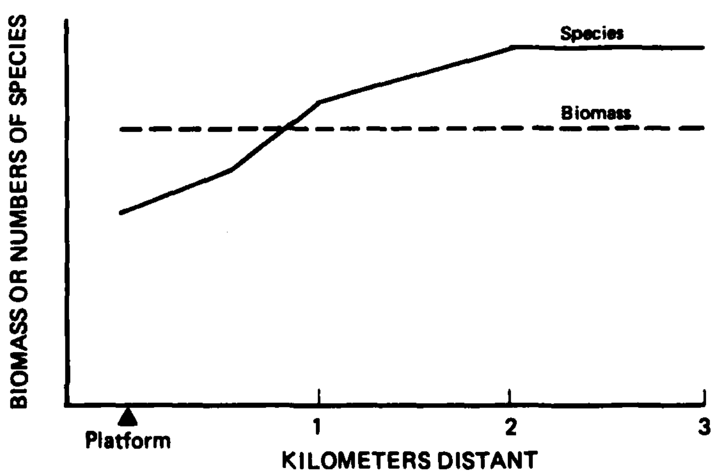
Studies by Battelle (1974) on Lake Maracaibo, Venezuela showed little impact of four decades of oil production in that unusual estuary; however, good control locations were difficult to locate because of the area's long production history. A similar criticism can be made of those studies on Timbalier Bay, Louisiana where Bender, et al. (1979) indicated little impact on benthic biota. Investigations by Straughan (1976) found no significant effects of chronic natural oil seeps at Coal Oil Point, California on either biomass, species abundance or diversity of benthic populations.

Armstrong, et al. (1979) demonstrated a reduction in benthic species and biomass related to oil field brine effluents in Trinity Bay, Texas. They attributed the effects observed to concentrations of naphthalenes in the bay sediments. The effects were localized

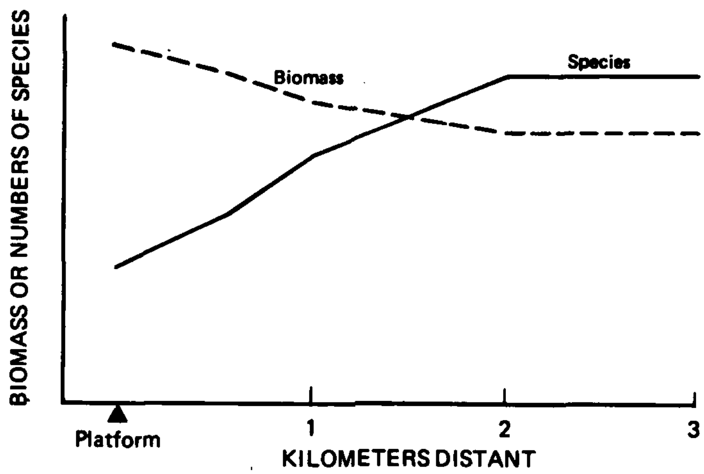
Example C - Reduction in Species Diversity and Biomass of Benthic Animals



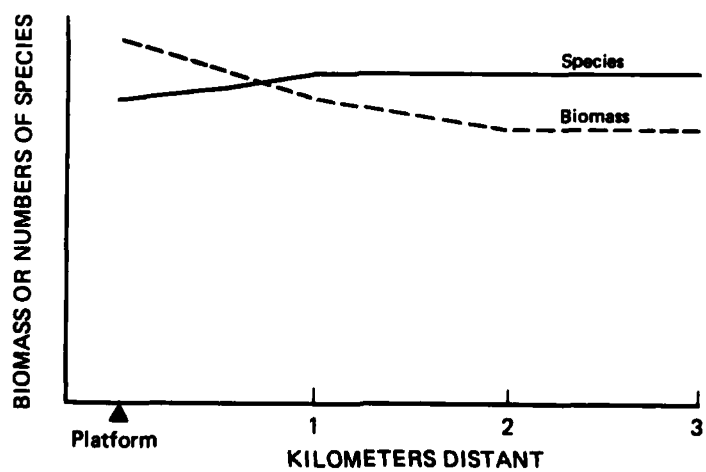
Example D - Reduction in Species Diversity but not Biomass of Benthic Animals



<u>Example E</u> - Reduction in Species Diversity but an Increase in Biomass of Benthic Animals



<u>Example F</u> - Increase in Biomass, No Change in the Number of Species



with recovery occurring at stations located 455 m from the platform. The authors caution that the "application of the outcome of this study to deeper waters must be made with extreme caution." Addy, et al. (1980) reported the reduction in abundance of certain benthic organisms within about a 2 km radius of the storage tank in the Ekofisk oil field. The authors suggest that the changes in community structure are due to oil pollution and other factors such as mechanical disturbance. Most of the effects were due to reductions in populations of one species of polychaete worm, Myrochele oculata.

A series of studies describing the short-term effects of drilling discharges in the mid-Atlantic region has just been completed. In these investigations, the physical and chemical fate of drilling muds discharged from an exploratory rig located 156 km east of Atlantic City, New Jersey in 120 meters of water are described. During the six month drilling period, 752 metric tons of barite, 1409 metric tons cf low gravity solids (bentonite plus natural formation drill solio and 95 metric tons of organic chemical (chrome lignosulfonate, lignite and cellulose polymer) were discharged.

In regard to the fate of this material, Ayers, et al. (1980) concluded the following:

1. The majority of the discharged material was carried away from the rig by prevailing currents. Slightly different distributions were recorded for low gravity solids and barite.
2. Drill solids from the natural formation were the major source of most trace metals in the discharge.
3. Suspended solids levels reached background levels at 350-600 meters down-current of the discharge source and transmittance values within 800-1000 meters.

Chemical and physical alterations in the benthic environment were described by Mariani, et al. (1980). These investigations concluded:

1. That sediments increased in clay content in the vicinity of the well and these changes were noted to extend to about 800 meters from the well.
2. Increases in concentrations of certain heavy metals were detected during the post-drilling survey; however, the levels of lead and zinc were within the ranges of natural variability for the area. Nickel and vanadium also showed increases, but probably were not related to drilling.
3. Brittle stars, molluscs and polychaetes had higher barium and mercury levels than in pre-drilling samples. However, the source of mercury is unknown, and sediments were all below the detection limit.

The effects of the drilling discharges on the benthic community were studied by Menzie, et al. (1980). These investigators found:

1) Fish and crabs increased substantially in the immediate vicinity of the well and over the study area to the south of the well site.
2) Densities of the most abundant, large benthic species, the sand star, were unaffected by the discharge.
3) Reductions in abundance of other benthic organisms were attributed to increased predation by fish and crabs and to the increased clay content of the sediments.
4) Benthic populations are expected to return to normal as the bottom sediments are reworked and new material deposited in the area.

The results outlined above were presented at a recent joint government-industry symposium entitled "Research on Environmental Fate and Effects of Drilling Fluids and Cuttings" held in Lake Buena Vista, Florida, January 21-24, 1980. A preliminary review of the other studies presented at this meeting leads one to conclude that under normal circumstances no significant environmental impacts should result from drilling discharges except in the immediate vicinity of the platform.

Toxicity of certain fluids to marine animals has been demonstrated in the laboratory, but at very high concentrations compared to expected field levels.

I do not wish to dismiss all concerns associated with the discharge of drilling fluids, since circumstances could exist in which effects on benthos may be significant. Consider, for example, an area of intense development in which the discharged particulates are funneled to depositional sinks. At sites such as these, long-term effects could result. The potential for these conditions to exist should be recognized and dealt with when necessary, i.e., special requirements for discharges could be applied in such cases.

Unfortunately, the results of few, if any, additional studies conducted in the pre- and post-development phases are available for us to evaluate. To supplement our data base, we might consider the use of ecological data developed from comparisons of undeveloped and developed regions, the use of data developed from spills and extrapolations from laboratory studies. However, if we use spill or laboratory data, we must remember one of the most important considerations in toxicity studies, i.e., the effects observed are a function of concentration and length of exposure.

Reish, et al. (1980) compared polychaete populations from four bays in the Gulf of Mexico to determine the long-term cumulative effects of oil drilling and production on community structure. They concluded that "while the polychaete species composition of Timbalier Bay (the most developed area) was different than that of the three Texas bays, there is no indication, based on a comparison of several characteristics of the community structure, that the polychaete community of Timbalier Bay shows any adverse effects of long-term petroleum drilling and production."

In considering the potential effects of oil spills, the environment in which the oil is spilled is very important in determining the oil's fate and whether damage will result. Along the coastline of the United States accidents can occur in a wide variety of marine environments ranging from the open ocean to major bays and estuaries. Oil spillage could result from a well blowout, pipeline break, tanker accident or loading mishap. The total yearly input of petroleum hydrocarbons to the world's oceans is estimated to be 6 million metric tons, 2 million tons of the total are derived from marine activities. Prior to the Campeche spill only 0.008 metric tons/year were attributed to spills from platforms.

The ecological danger of any spill is governed to a great extent by the type of plants and animals living in an area. In the open ocean, for example, the density of both plant and animal life is relatively low because of short supplies of nutrients on which plankton depend. For this reason, deep-water spills present a minimal threat to the marine environment. But as you draw near the shore and water depths decrease from thousands to hundreds of feet, nutrients in the water increase and plankton become more abundant. Exchanges between the water column and bottom increase and large populations of fish thrive in the food-rich water. Any spill along these coastal waters has the potential for doing great harm.

After oil is spilled, a variety of things begin to happen. As the oil spreads out into a slick, it begins to weather. Sunlight starts to oxidize some of the chemical components. In some cases this process may actually increase the toxicity of some compounds while others begin to break down. The lighter and generally more toxic compounds evaporate causing a decrease in their concentrations in the oil slick. Within 7 to 14 days, evaporation may remove about 50 percent of the hydrocarbons in an average crude oil. At the same time, hydrocarbons dissolve in the water or become emulsified. Oil also adheres to minute particles in the water and sinks to the bottom. Along with chemical oxidation, biological breakdown takes place, although at a lower rate. Over the long term, biological processes are, however, an important factor in the breakdown of spilled oil.

Serious ecological damage can result from offshore spills when conditions result in the transport of spilled oil into shallow bays and estuarine waters. For example, estuaries are frequently bordered by marshes on which dense stands of grasses grow. An acre of marsh may produce over five tons of grass in a year. When these grasses die and decompose, they wash into the estuary at high tide and provide a rich food supply for a variety of organisms.

A spill reaching these waters can have a severe impact on marine life and the cycle of food production. As the oil enters the marshes, it sinks into the sediments and dilution and evaporation of the toxic components of the spill slow down. Toxic concentrations can be quickly reached and marine life near or in the bottom sediments, e.g., clams, oysters, may be killed. The marsh plants may also be coated and killed by the oil, thus depriving higher forms of an important food supply.

The actual effects of oil on wetland vegetation observed in field studies appear to be a function of both the type and quantity of oil spilled. The following three examples which illustrate effects are all drawn from research conducted in the lower Chesapeake Bay.

In one study, Bunker 'C' oil came ashore in marshes along the eastern shore of the Bay in February of 1976. As much of the oil as possible was physically removed from the marshes by cutting the naturally dead grass to which it was sticking. By April of 1976, the marsh had recovered (Hershner and Moore, 1977).

The effects of No. 2 fuel oil on marsh grasses were studied through a series of experimental spills in an area on the western shore of the Bay. In this case, the oil killed the marsh grasses that normally stabilize the shoreline with their extensive root systems. After the grass was killed, erosion of the shoreline occurred making recovery impossible (Hershner, 1978).

In a third study, the effects of fresh and weathered crude oil were investigated (Bender et al., 1980). Marshes were dosed with oil of both types and studies to determine ecological effects were conducted for a period of four years. Effects of the spills on phytoplankton were short-lived with recovery occurring within one week (Figure 1). No changes in species composition were observed. However, the marsh grasses were affected for a period of two years (Figure 2). The year following the spills, the standing crop in the oiled areas was only one-third of that in the control area. Increased production was evident in the second year and recovery complete during the third year. Benthic animal life was affected for at least three years following the spills (Figures 3 and 4).

Additional studies (e.g., Michael et al., 1975), have demonstrated relatively long lasting effects on benthic animals following spills. However, other investigations of spills have shown either rapid recovery or little impact (Chan 1975; Clark et al., 1975; McAuliffe et al., 1975). Time prohibits an extensive review and criticism of the numerous post spill investigations. A synthesis of the results from these studies does, however, permit the following generalizations on the potential for ecological damage resulting from spills. Significant damage is more likely to result if: 1) the spill occurs in or is transported into shallow waters; 2) weather conditions promote the mixing of the oil into the sediments; 3) refined oils are spilled; and 4) conditions of current, tide and/or geology lead to prolonged exposure times.

Laboratory investigations have provided a knowledge of: 1) which components of petroleum are most toxic to marine animals; 2) uptake and depuration rate; and 3) carcinogenic potential.

The acute toxicities of most oils have been shown to be related to their content of aromatic compounds. Of the aromatics, the substituted napthalenes and various three ringed compounds are the most toxic, with LC_{50} values in the low part per million range. Crude oils contain between 0.1 - 10 percent aromatics by volume.

PHYTOPLANKTON

PRIMARY PRODUCTIVITY

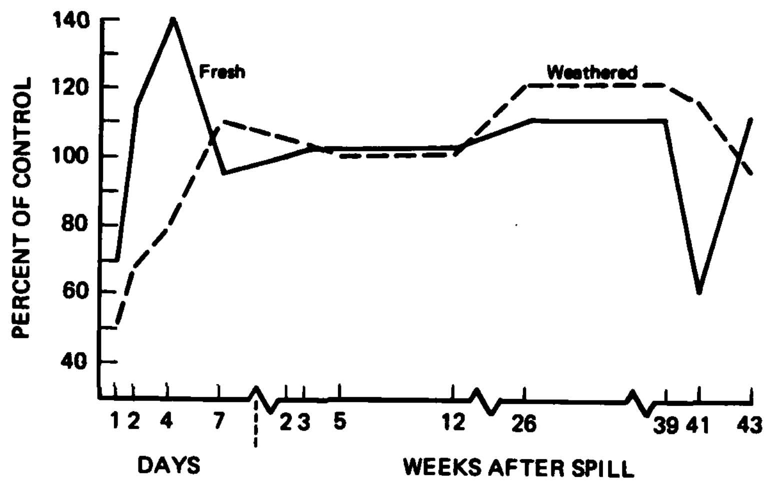


FIGURE 1

MARSH GRASS

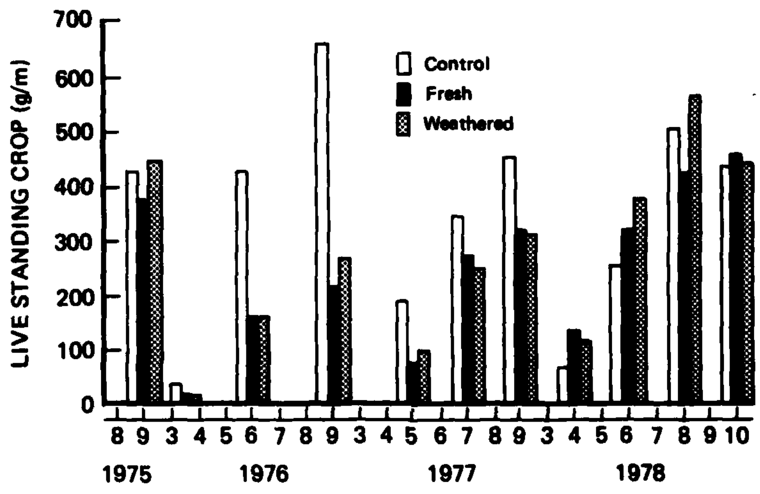


FIGURE 2

PELOSCOLEX

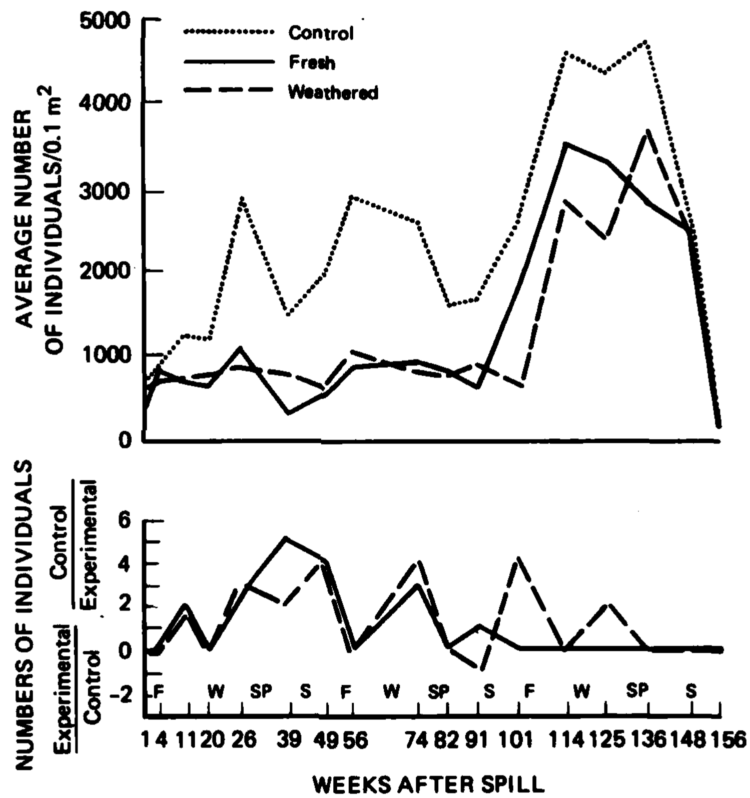


FIGURE 3

BENTHIC BIOMASS

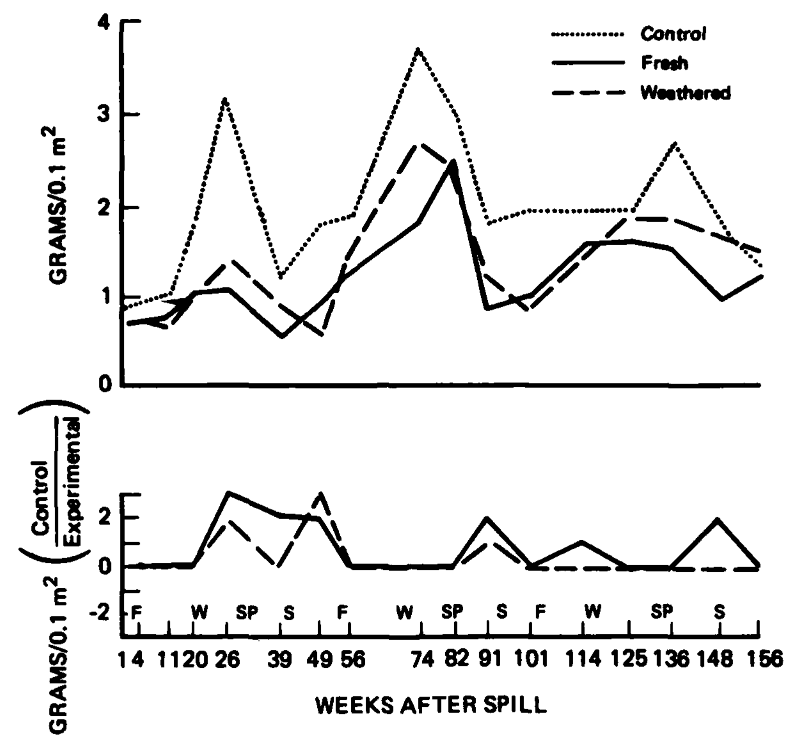


FIGURE 4

Most marine organisms rapidly accumulate petroleum hydrocarbons from solution and depurate them when returned to clean water. Fishes and most crustaceans have the ability to metabolize petroleum hydrocarbons where molluscs do not.

Recent studies by Payne, et al. (1979), have been directed at determining whether petroleum hydrocarbons are an important source of mutagens in the marine environment. These authors determined the mutagenicity of 12 different types of crude and refined petroleum hydrocarbons. Only used engine oil was observed to be mutagenic. The authors concluded, "the belief that oil-spill-derived hydrocarbons could be a primary source of mutagenic activity in the marine environment is argued."

Conclusions

At present our knowledge of the long-term effects of offshore oil development is not sufficient to suggest changes in regulations related to environmental protection. Conflicting information exists as to the existence of impacts, and the one study that did identify a cause was conducted in a very shallow water environment not characteristic of offshore development.

The above conclusion does not imply that specific offshore regions, especially in frontier areas, should not be given special attention. And, if environmental conditions exist that warrant more restrictive control measures, they should be developed and applied specifically to those areas.

Spills in certain circumstances can cause considerable environmental damage; however, most of these result from marine transportation, which is beyond the scope of this investigation. Pipeline regulations with respect to protection of the environment will be considered in another document.

Michael E. Bender is Senior Marine Biologist in the Department of Ecology and Pollution, Virginia Institute of Marine Science, located in Gloucester Point, Virginia. Dr. Bender is a member of the Committee on Assessment of Safety of Outer Continental Shelf Activities.

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ENVIRONMENTAL EFFECTS OF OIL IN THE MARINE ENVIRONMENT

by

Howard L. Sanders

A massive pollution incident can have a severe impact on the marine environment. However, there is considerable disagreement among scientists on what effects smaller pollution events may have, especially low level chronic pollution from offshore production operations. There have been few studies on the effects that oil extraction from the seafloor has on the marine ecosystem. Furthermore, with two recent exceptions, such studies have not been undertaken until years after oil industry operations were initiated.

Offshore Ecology Investigation

By far the most widely publicized and frequently quoted of these studies has been the Offshore Ecology Investigation (OEI) by the Gulf Universities Research Consortium (GURC), conducted off the central coast of Louisiana, the location of the largest and most active oil production operations in the marine environment for more than thirty years. The GURC studies, the keystone of research supported by the oil industry (1974 and unpublished), were carried out by 23 principal investigators from 14 universities and research institutes in the Gulf Coast region. The investigation was supported by eighty oil and oil-related companies that provided 1.5 million dollars for a two-year investigation with the objective of determining whether petroleum exploration, drilling and production operations have had any significant irreversible effects on environmental quality or ecological health in estuarine Timbalier Bay or in the study area on the adjoining continental shelf.

The final reports of the principal investigators contain thousands of pages of data, results, conclusions, figures, tables, references, and appendices. This primary source material, however, has not been distributed widely. The final reports were submitted to the Project Planning Council, a group of four who wrote the Final Project Planning Council Consensus Report (GURC Report No. 138, 1974). This small paper, the Consensus Report, became the source of information for the OEI/GURC Investigation.

The Consensus Report was widely circulated to politicians, civil servants, decision-makers, molders of the public opinion, the media, industrialists, scientists and the general public. Representatives for the oil industry persistently cite the report as proof that even major oil production over decades has little or no effect on the marine environment. As one of numerous possible examples, Edward W. Mertens, Chairman of the Environmental Oil Effects Committee, American Petroleum Institute, states (1976) that the resulting investigation represents ". . . undoubtedly the most comprehensive study concerning the effects of chronic exposure to marine life ever attempted," that the findings of these studies show that "no measurable effects (of oil) have been observed on such indicators of the health of local marine communities as population levels of various organisms; species diversity; and size, growth rate, or reproductibility of various organisms," and that "every indication of good ecological health is present." Mertens concludes from these studies that "low-level chronic exposure to crude oil has, at most, negligible effect on marine life."

Until 1980 (see below) only groups associated with the Gulf Universities Research Consortium or the oil industry reviewed the final report. How faithfully, then, does the Consensus Report reflect the contents of the individual reports submitted by the principal investigators? Were some kinds of information omitted? Were the conclusions valid? Can the same data be construed another way? Were some fundamental aspects of the investigation omitted from the GURC/OEI Program?

Because the disparity between the findings obtained in our study of the FLORIDA spill off West Falmouth, Massachusetts (Sanders, H. L., Grassle, J. F., Hampson, G. R., Morse, L. S., Garner-Price, S. and Jones, C. C. 1980. Jour. Mar. Res. 38: pp. 265-380), with its clear documentation of long-term chronic effects, were in sharp contrast to the conclusions for the GURC/OEI Investigation as found in the Final Project Planning Consensus Report, we have obtained and critiqued most of the Final Reports, the primary source of data for the GURC Offshore Ecology Investigations. Our conclusions based on this review follow.

Validity of the Control Stations. Although the claim that conditions found at the platforms do not differ appreciably from those found at the control stations is true, the interpretation of this similarity offered by the Consensus Report, that damage to the ecosystem has not occurred during nearly forty years of exploration and development, is unlikely. The sampling strategy adopted consisted of selecting an active production platform in Timbalier Bay near Philo Brice Island and a control site in the bay of similar depth, sediment, temperature and salinity regimes and similar in other environmental conditions but supposedly remote enough not to be exposed to any of the possible impacts from petroleum or other stresses resulting from oil industry activities. The control station was about eight kilometers from the Philo Brice Production Platform. At present, we have no knowledge of the locations of other production platforms and drilling sites in Timbalier Bay. On the adjoining Louisiana Shelf, in a more marine environment, Exxon Production Platform 54A was selected as the production site for study and its control was placed 9 kms to the Northeast. In response to seasonal currents, the control was upstream for eight months but downstream for four months from Platform 54A. However, the validity of the control stations chosen by the Ecological Planning Council is seriously, if not fatally, flawed.

Oppenheimer, Miget and Kator (GURC/OEI, 1974) concluded through visual observations, the data resulting from their first cruise, and from a literature search that the platform stations and their controls were too uniform because of oil activities in the area, i.e., the influence of tidal and current movements (Oetking, GURC/OEI, 1974), wind and wave activity and turbulence, the discharges caused by oil industry activities became uniformly spread over a larger area that included the control sites. As a result, Oppenheimer et. al., established distant controls on the shelf off western Louisiana and Texas that were supposedly remote from active oil fields. Thus, the same Louisiana control sites selected by the OEI Planning Council must be equally inappropriate for the majority of the other studies comprising the GURC investigation. Yet, alternate distant controls were not established for the other studies.

Other investigators similarly point out the inadequacies of the controls. Brent, Williams, Bergin, Tyvoll and Meyers (GURC/OEI, 1974), in their study of organic carbon and dissolved oxygen in the water column, stated that they were unable to answer the question of whether the offshore or inshore (Timbalier Bay) oil industry activities effect the ecosystems in which they operate. It remained unanswered because of seasonal fluctuations and because the controls are in the same ecosystem with the platforms, i.e., the controls are exposed to spills and leakage from platforms and storage and piping facilities through wind-driven wave transport, along with tidal and prevailing current transport.

Montalvo and Brady (GURC/OEI, 1974), who determined the concentrations of total mercury, lead, cadmium, zinc and arsenic in the water column of Timbalier Bay and the study area on the Louisiana Shelf, pointed out that ". . . since oil production has been going on in the general area of the Louisiana coast for many years, it is questionable if the values obtained, even in areas remote from oil platforms, can be considered truly representative of conditions that existed before oil exploration began. . . ."

El-Sayed (GURC/OEI, 1974), the principal investigator in the phytoplankton and primary production study, also recognized this dilemma by less overtly questioning the validity of the control sites; "The results of the present investigation would have been more meaningful had we any data from baseline studies undertaken prior to construction of oil platforms in the Gulf of Mexico some 40 years ago. Any deviation from the 'norm' (pre-platform days) could be, in part, associated with oil operation."

Kritzler (GURC/OEI, 1974), who studied the benthic polychaete worms in Timbalier Bay, decided that his findings ". . . cast doubts on the validity of the controls. The Production Platform Control area was picked because of the absence of oil or gas wells, although a high pressure gas pipeline runs through the middle of it." He concludes ". . . that the controls are inappropriate--if any good at all--to the study for which they were selected." He believes ". . . that any determination as to whether long-term oil production and drilling in Timbalier Bay has had a major impact on the polychaete fauna must await the results of a parallel study that would have to be conducted in a bay of similar origin and characteristics, but not yet exploited by the oil industry."

These widespread doubts voiced by a number of the principal investigators in their individual final reports regarding the validity of the controls never made it into the Consensus Report. Nor is any mention made of the fact alluded to by a number of the principal investigators that petroleum hydrocarbons and toxic metals introduced into the water column through oil industry activities at production platforms were spread over larger areas. These included the controls in more or less equal concentrations and resulted in little difference between concentrations of petroleum hydrocarbons found near the production platforms and their controls.

The Consensus Report correctly informs the outside world that no significant differences could be found between production platforms and their controls both offshore and in Timbalier Bay in: concentrations of dissolved oxygen, turbidity, trace metals, total alkalinity, nutrient salts, chlorophyll values, primary production, numbers and species composition of diatoms and dinoflagellates, means of single species copepod populations, zooplankton diversity index values, species diversity and standing crop of benthic molluscs and bivalves, benthic foraminiferans, etc. However, it chose to interpret such evidence as a demonstration that low-level chronic exposure to crude oil has, at most, negligible effect on marine life and that every indication of good ecological health is present rather than that the supposed controls together with the production platforms were uniformly exposed to the chronic low-level petroleum discharges.

Since the nearby controls proved to be compromised, what can be learned from the distant controls established by Oppenheimer et al. (GURC/OEI, 1974) for their hydrocarbon and microbiological studies in the water column? They found that the OEI study area did not differ appreciably in hydrocarbon concentrations or composition as compared to the so-called 'non-production Gulf' control areas several hundred miles away from the study site. They stated "We do not wish to speculate as to the origin of the petroleum derived hydrocarbons in the Gulf of Mexico at this time."

The source of this widespread petroleum derived-hydrocarbons becomes clearer from a study separate from the GURC/OEI Investigation. Sackett and Brooks (1974), using low molecular weight hydrocarbon concentrations in surface waters as indicators of marine pollution, determined the concentrations of these hydrocarbons from several thousand miles of cruise tracks in the Gulf of Mexico from 1971 to 1974. They found that large areas of coastal waters off Louisiana and Texas had up to six orders of magnitude higher concentrations of low-molecular weight hydrocarbons than open ocean waters. Sackett and Brooks attribute these elevated concentrations to offshore oil production operations. Such very short-chain hydrocarbons are rapidly broken down and, thus, their presence is indicative of recent pollution. These hydrocarbons, themselves, do not seem to be detrimental to marine life but they serve as indicators of the more resistant and more toxic petroleum components.

Nowhere in any of the original Principal Investigator Final Reports or in the Consensus Report are the numbers and locations of the production platforms on the Louisiana and Texas Shelf or in the various embayments such as Timbalier Bay given or discussed. Without such information, the reader has no way of judging the validity of the controls.

We found that on navigational charts for the coasts of Louisiana and Texas the positions of oil production platforms are designated because they are navigational hazards. From these charts, we were able to determine that there were more than 2,600 active oil platforms almost continuously present from just east of the mouth of the Mississippi River westward beyond the Louisiana-Texas border. These numbers are almost certainly minimal. In the 1979 version of the Final Report by Oppenheimer, Miget and Kator provide relevant background information, "The research area selected for the OEI is one of the most prolific oil-producing areas in the world. Development began in the late 1930's, and in August 1972, there were nearly 6,000 wells working from 1,900 platforms. . .the historical picture of oil production and exposure to the 400 square mile study area provides an excellent setting in which to determine the effects of oil production on a coastal environment" (pp. 290-291).

The investigations of Brent et. al., (GURC/OEI, 1974) on organic carbon, Laseter and Ledet (GURC/OEI, 1974) and Oppenheimer, Miget and Kator (GURC/OEI, 1974) on hydrocarbons document that pollution incidents from oil industry activities are frequent events at Offshore Production Platform 54A and the Philo Brice Production Platform in Timbalier Bay. Extrapolation of their finding to the thousands of other platforms plus the short transit time for a pollution event at one platform to diffuse and contaminate a much larger area of the Louisiana Shelf must result in a near constant chronic background pollution both in the OEI study area and elsewhere on the nearshore Louisiana Shelf.

We can now give the obvious explanation why the OEI study area and the distant 'non-production' Gulf control sites do not differ appreciably in hydrocarbon concentrations or composition. They are both in or near regions of active oil production. Any attempt to establish *bona fide* control sites in the OEI study area or elsewhere throughout the hundreds of miles of the Louisiana and near Texas Shelf would be an exercise in futility.

Microbial Degradation.-- With such general and widespread occurrence of petroleum hydrocarbons throughout the inshore waters of Louisiana, Oppenheimer et al. (GURC/OEI 1974) proposed a hypothesis to interpret this phenomenon which invokes high rates of bacterial biodegradation as a mechanism for keeping hydrocarbon concentrations below the level to cause any deleterious effects on marine life. They base their model on laboratory studies in which local crude oil from the Platform 54A site was incubated in flasks with mixed marine bacteria in well-oxygenated, nutrient-salt enriched seawater. Under these optimal conditions for degradation, there was a rapid reduction of the more readily degraded straight-chain and a slightly slower rate of degradation of the branched paraffins. However, a prominent unresolved baseline composed of a complex array of undifferentiated aromatics and cycloparaffins persisted.

Initially, they were properly cautious interpreting these results by stating "This indicates that even under optimal growth conditions the compounds composing this unresolved baseline were not degraded. Very little is known about degradation of these compounds especially in the field where the nutrient regimes do not favor the rapid rates of degradation measured in the laboratory." They suggested that "the unresolved baseline found in hydrocarbon extracts from seawater taken throughout much of the nearshore Gulf of Mexico is degraded hydrocarbons and, because of its widespread occurrence in geographically distant samples, the nearshore Gulf is in some type of dynamic equilibrium." However, this sober and measured interpretation has been transformed in the summary to read "The microbiology results indicate a rapid uptake of hydrocarbons indicating the transitional nature of residuals and oxidation production." It is this transformation that was incorporated in the Consensus Report and it is this version that was communicated to the outside world.

Transfer of Petroleum Hydrocarbons to the Seafloor. One of the truly major omissions in the GURC/OEI Investigation is the total absence of any information on the passage of petroleum hydrocarbons from the water column into the bottom sediments. Sediments, particularly in shallow waters, serve as the ultimate sinks for oil spilled or leaked into the water column. A not very extensive review of the literature revealed more than 30 citations documenting this very general phenomenon for a wide variety of crude oils and refined products. Findings from some of the more readily available papers follow.

In the area of the FLORIDA spill, off West Falmouth, Massachusetts, the light #2 fuel oil adhered to particulate organic matter and fine sedimentary particles in the water, and rapidly settled to the bottom (Blumer & Sass, 1972). There, the oil degraded very slowly, and spread over the bottom, probably in part by resuspensions months and even years after the spill. Crude oil from the blowout at the Santa Barbara Platform initially reached the bottom sediments by the same mechanism operative off West Falmouth, and later spread along the bottom to cover much of the floor of the Santa Barbara Basin to water depths of 500 m (Kolpack, 1971). After the spill of heavy Bunker C oil from the ARROW into Chedabucto Bay, Nova Scotia, the petroleum hydrocarbons dispersed widely throughout the water and in the subtidal sediments (Scarratt & Zitko, 1972). In the massive spill from the AMOCO CADIZ off Brittany, fine droplets of light crude oil were absorbed by suspended sedimentary particles; a large quantity of oil reached the seafloor within two weeks (Cabioch, Dauvin & Gentil, 1978). Once on the bottom, this oil travelled along the bottom with the silt (Spooner, 1978, p. 284). Toxic effects of the oil became manifest 90 km from the wreck five days after the spill began. In the study of the TSESIS spill in the northern Baltic Sea, off Sweden, sediment traps were placed in the water column 20 m below the surface, to measure the quantity of heavy #5 fuel oil absorbed on settling organic and sedimentary particles (Johanson 1979). The #5 fuel oil composed as much as 0.7 percent of the sedimented matter recovered from the traps in the two weeks following the spill. Studies of the effects of the FLORIDA and ARROW spills were continued for several years. Oil residues from both accidents are present in some of the bottom sediments a decade later.

In the study of the ARROW spill in Chedabucto Bay, Nova Scotia, the zooplankton ingested small globules of oil in the water column. Conover (1971) found that their faecal pellets contained as much as 7 percent Bunker C oil. He calculated that about 20 percent of the oil was sedimented to the bottom as zooplankton feces. Wiebe, Boyd, and Winget (1976) measured the rate of sinking of zooplankton faecal pellets and found that they sank at an average speed of 171 meters per day at a water temperature of 22°C and 151 meters per day at 5°C. Oppenheimer, Miget and Kator (GURC/OEI, 1974) found oil residues present in each of the eight zooplankton samples they analyzed. These three bits of information strongly suggest that zooplankton faecal pellets provide a major and rapid route for transporting oil from the water column onto the bottom in the shallow GURC/OEI study area.

Hydrocarbons in the Sediment. The very high concentrations of organic carbon in the water column, 5-20 mg/l, reported by Brent et. al. (GURC/OEI 1974) show that the OEI study area is ". . .one of the most organically rich ecosystems in the world of its type, quite atypical for an "open" continental shelf region." Laseter and Ledet (GURC/OEI 1974) revealed that the bottom sediments in the OEI study area were contaminated by fossil fuels. Their evidence is based on the pristane/phytane values which show high concentrations of phytane, the presence of normal hydrocarbons in the range of $\underline{n}-C_{15}$ to $\underline{n}-C_{24}$ with both odd and even numbers of carbon atoms in about equal abundance, and the presence of alkylbenzenes and napthalenes similar to those of local crude oil. Both the high concentrations of phytane and the presence of normal paraffins having both odd and even numbers of carbon atoms in about equal abundance indicate recent incidents of pollution. The mean values given by Laseter and Ledet for the heptane and benzene eluates that include the paraffins and aromatics respectively are together equivalent to the total hydrocarbons measured by Blumer and Sass (1972) for samples taken near West Falmouth. Mean values obtained from the intertidal and subtidal zones of Timbalier Bay and from the offshore Louisiana stations were present in concentrations shown to be stressful or lethal to benthic animals in the

West Falmouth study. It must be borne in mind, however, that the maximal normal concentrations of biogenic hydrocarbons is 10 mg in 100 g dry sediment in Buzzards Bay, including the West Falmouth area, whereas the normal concentration of biogenic hydrocarbons in the OEI study area has yet to be determined. Yet, such information is of absolutely fundamental importance to the objective of the entire GURC/OEI investigation as expressed by Tyson (Tyson and Menzies, 1973, p. ii) as follows:

> "A principal reason for participation in GURC activities by its offshore Industry Affiliates resides in their serious concern for the possible impacts of their operations on the natural environment."

It is inexplicable that such vital knowledge as the concentrations of petroleum hydrocarbons present in the bottom sediments is missing from the Offshore Ecology Investigation. Without such central information, how can one evaluate possible impacts resulting from oil industry ". . .operations on the natural environment?"

Benthos. Without severe pollution or other stresses, the inshore coastal sediments of Louisiana should probably support a very abundant benthic fauna. The primary productivity in the overlying water column is the highest in the Gulf of Mexico (El-Sayed, 1974, GURC/OEI), the water depths are shallow enough that a large proportion of the products of primary production in the form of algal cells reach the seafloor either intact or slightly degraded. These cells, faecal pellets from myriad zooplankton grazing on the phytoplankton, and abundant detritus typical of any organically rich shallow-water environment, provide a rich source of food necessary for the support of high numbers of benthic animals in all but the most severely stressed sedimentary habitats. We compare the findings from the various benthic studies of the GURC/OEI with those of several benthic investigations of shallow marine habitats elsewhere in the world, in an effort to ascertain whether there has been any deleterious effects from oil industry activities on the benthic fauna in Louisiana coastal waters.

After correcting for the differing mesh sizes used in processing the samples in the various studies, this comparison revealed significantly lower faunal densities from the GURC/OEI studies independent of whether the comparison is restricted to polychaetes (Fish et al., GURC/OEI 1974, intertidal; Kritzler, GURC/OEI 1974, subtidal in Timbalier Bay) or included the total fauna (Farrell, GURC/OEI 1974, subtidal Timbalier Bay and Louisiana Offshore Shelf; Waller, GURC/OEI 1974, subtidal Timalier Bay and Louisiana Offshore Shelf). Among the 344 density comparisons made between the GURC and non-GURC benthic studies, the Null Hypothesis that densities found in the GURC vs non-GURC samples are not significantly different was rejected at the $\leq$ .002 probability level for 256 of the comparisons (75.29 percent), at the $\leq$ .02 probability level for 37 of the comparisons (10.76 percent), at the $\leq$ .05 probability level for 15 of the comparisons (4.36 percent) at $\leq$ .10 probability level for 13 of the comparisons (3.78 percent) and was not significantly different at the $\geq$ .10 probability level for 20 of the comparisons (5.81 percent).

In all cases, except for some of the 20 comparisons with p values > .10, the GURC densities were invariably smaller and usually decisively smaller than the non-GURC densities. Some of the non-GURC stations included in the p values > .10 pairings were the three severely oiled stations, accounting for nine of the pairings, from the West Falmouth study which remained heavily contaminated during the three years of the sampling period (Sanders et. al., 1980) and four pairings with a heavily polluted station in upper Biscayne Bay within the City of Miami, Florida (Rosenberg, 1976).

<u>The Dominant Benthic Species</u>. Besides having low numbers, the benthic infauna of the GURC/OEI study was characterized by pronounced dominance by two highly opportunistic species, the bivalve, <u>Mulinia lateralis</u> and the polychaete, <u>Spiochaetopterus oculatus</u>.

<u>Mulinia lateralis</u>. This bivalve comprised 52.1 percent of the molluscs and crustaceans found by Farrell in Timbalier Bay. If we eliminate environments where <u>Mulinia</u> is rare or absent, sediments having more than 96 percent or less than 5 percent sand or low salinities (< 13 o/oo), then <u>Mulinia</u> numerically contributed 79.4 percent of the mollusc-crustacean component of the Timbalier Bay benthos. Offshore, three stations were intensively sampled. Two of them, Production Platform 54A and a control site chosen by Farrell had sediments that were almost entirely composed of sands (97.1 and 98.9 percent). At one of these stations, <u>Mulinia</u> was represented by two individuals and at the other the bivalve was absent. At the third station, composed of muddy sand (82 percent sand), the 1972 specimens of <u>Mulinia</u> collected formed 92.4 percent of the molluscs and crustaceans.

The abrupt and extreme changes in density documented by Farrell for <u>Mulinia lateralis</u> in the GURC/OEI study area in Timbalier Bay and on the Louisiana Shelf are not unusual events. Such pronounced, aperiodic and ephemeral eruptions seem to be typical of this species (see Sanders 1956 for Long Island Sound; Boesch 1974 for the somewhat polluted Hampton Roads Port area in Virginia; Boesch, Wass and Virnstein 1976 for a long-term study in the lower York River estuary, Virginia; Holland, Mountford and Mihursky 1977 for a three-year study in a mesohaline regions of Chesapeake Bay; and Stickney and Perlmutter 1975 for the two year study in the Intercoastal Waterway of Georgia). <u>Mulinia</u>, with a generation time of only two months, continuous gametogenesis, a remarkably high reproductive potential averaging 3-4 million eggs per spawning, planktotrophic larvae that allow for wide dispersal, extremely high mortality rates particularly in the younger stages, broad physiological tolerances that permit survival under rigorous and/or stressed conditions, the ability to rapidly exploit biologically undersaturated environments, sudden explosive appearances at sample sites in dense populations often followed by a virtual disappearance in 2-6 months that result in an ephemeral and erratic presence in time and space, document this bivalve as an opportunist *par excellence*.

Sanders (1956) described a widely distributed benthic community in the soft muds of Long Island Sound at depths greater than 10 meters. Rhoads, McCall and Yingst (1978), in their quest to locate a benthic control station for a dredge spoils dumping ground in this sedimentary regime, discovered that " . . . it is difficult today to find a community at the mature successional stage described 20 years ago by Sanders (1956). Clearly, much of Long Island Sound is already a compromise system." Both the intensive studies by Rhoads and colleagues and a more spatially extensive macrobenthic investigation by Reid (in preparation) were initiated in 1972 and continued for a number of years. The most dramatic alteration from the earlier study by Sanders in 1972-1974 was the dominance of *Mulinia laterialis*. In contrast to an average 2.32 percent contribution by *Mulinia* in Sanders' samples, this highly opportunistic bivalve composed an average of 79.0 percent of the benthic fauna over extensive areas of this bottom in Reid's samples in the summer of 1972. Rhoads and Michael (1974) attempted historically to measure possible environmental degradation in Long Island Sound. They carefully determined the distribution of mollusc shells by depth in 30 gravity cores taken in central Long Island Sound. With isotope techniques they were able to show that the upper 20 cm of the cores represented the last 44 years of sedimentation. They found that in the top 20 cm densities of *Mulinia lateralis* were much greater than in the deeper sections of the cores. "We believe (they say) this distribution reflects changing environmental conditions rather than reflecting shell destruction at depth or decrease in rate of sediment resulting in concentration of shells. The upper 20 cm of the cores also coincides with an increase in organic carbon and trace metals." These increases in trace metals concur with the trace metal study of Goldberg et. al. (1977) in nearby Narragansett Bay, Rhode Island that revealed concentrations of trace metals were greater in the more surficial bottom sediments than in deeper sediments deposited in the early decade of the last century.

Spiochaetopterus oculatus. This worm made up 83.9 percent of the polychaete fauna at Kritzler's study sites in Timbalier Bay. McNulty (1961), in his benthic survey of the biota of Biscayne Bay, Florida, observed that *Spiochaetopterus oculatus* was one of the few species found in the more severely polluted but not yet azoic sediments of Miami Harbor. He concluded that *Spiochaetopterus* was a percise indicator of pollution.

The best evidence that *Spiochaetopterus oculatus* is an indicator of pollution comes from the elegant research of Dr. Barry A. Wade and his colleagues in their careful, detailed analysis of the benthos of Kingston Harbor, Jamaica, which demonstrates the deterioration of the environment and of the bottom fauna from 1968 through 1974 (Wade 1972a, 1972b, 1976; Wade, Antonio and Mahon, 1972). Kingston Harbor is the major deepwater port for Jamaica and has a population of more than a half million along its shores. This body of water has been exposed to increasing stress from a variety of sources: organic wastes from sewage outfalls, septic tanks, a soap and detergent factory, slaughterhouse discharge, etc.; petroleum wastes from a refinery and ship discharges, and accidential spills in the harbor; and from solid wastes.

Kingston Harbor, 16.5 km long and from 9.5 to 6.5 km wide, consists of two deeper basins from 9.5 to 18.3 m deep, the Outer Harbor and Inner Harbor which gradually deepen eastward to the head of the harbor. The sediments are primarily silts and clays in the deep basins. In his initial survey of the benthic communities of Kingston Harbor in 1968, Wade (1972a) was able to define different faunal zones in the soft sediments. There was a small abiotic zone at the extreme east end of the Inner Harbor; the neighboring poorly oxygenated zone with a fauna of low diversity in the eastern end of the Inner Harbor that was numerically dominated by Spiochaetopterus oculatus which comprised 96.4 percent of the fauna; a more diverse community in the aerobic sediments of the central and eastern parts of the Inner Harbor that occupied the greater part of that basin and was numerically dominated by the polychaete Chaetopterus variopedatus that comprised 47.5 percent of the fauna; and in the physically stable, benign, and healthy environment of the Outer Harbor, there was an extremely diverse community, with the three most abundant species together forming only 21.5 percent of the total fauna (Wade, 1972b).

Two further surveys in 1970 and 1971 (Wade, Antonio and Mahon, 1972) showed a very rapid degradation of the harbor environment. "Between 1968 and 1971, Chaetopterus had completely disappeared from the Inner Harbor and Spiochaetopterus had moved westward to take over its place. Where previously Spichaetopterus had occurred, the bottom had become abiotic and this now covered more than half the area of the Inner Harbor. Only the healthy Outer Harbor benthos appeared unchanged in the 1971 survey.

During the next three years, Wade continued to follow these dynamic changes in the benthic populations. Again, there was a gradient of well-defined zones from very polluted (Azoic) to healthy, from within the Inner Harbor to the Outer Harbor. Wade noted for the first time a deterioration in the pristine Outer Harbor environment. Evidence for this deterioration was a reduction in the species richness, and the increased proportion of species suggested as indicators of mild pollution together with their growing numerical dominance in the community.

On the basis of the accumulated data demonstrating the dynamic changes in the benthic fauna of Kingston harbor from 1969 through 1974, Wade (1976) proposed the polychaetes Capitella capitata and Spiochaetopterus oculatus as likely biological indicators of heavily polluted or unhealthful conditions for the shallow mud habitats of the Caribbean region.

Wade (1976, Vol. 2, pp. 26-27) summarized the information on Spiochaetopterus as follows: Spiochaetopterus oculata ". . . has always been found next to the most polluted area in the Inner Harbor. As pollution has spread and the abiotic zone has grown to cover most of the Inner Harbor, Spiochaetopterus has shifted its distribution more than any other species and, by 1974, it has virtually disappeared from the Inner Harbor, occurring only in a small area in the Outer Harbor. . ." Spiochaetopterus ". . . of all the others found in Kingston Harbor appears to be the most tolerant to low oxygen conditions," where it commonly was present at densities as high as $2000/m^2$ and comprised more than 95 percent of the faunal density. As the center of population shifted from the eastern end of the Inner Harbor westward and eventually into the Outer Harbor, densities declined steadily to less than 10 individuals/m^2.

Findings in the GURC/OEI Benthic and Fish Studies. The Fish, Massey, Inabilet and Lewis (GURC/OEI, 1974) study of the intertidal benthic fauna of Timbalier Bay, consisted of sampling two stations near production platforms and two control sites. Each station near a production platform and its control were physically and chemically similiar. The one group present in adequate abundance in these small samples were the Foraminifera. Fish et. al., found that the foraminisferans from the two stations located close to the active production platforms ". . .consistently yielded a lower calculated species diversity index than did their corresponding control sites. As the only observable difference in each pair of stations were their proximity to active oil wells, the above data indicates that the environmental stress that was recorded for these environments may have been caused by nearby active oil production sites" (p. 88). Yet, they caution that "without sufficient hydrocarbon data, it is difficult, if not impossible, to make a definite statement concerning the impact of active oil production on the distribution and abundance of Foraminifera in Timbalier Bay" (p. 87).

Perry's (GURC/OEI, 1974) sampling of bottom fish and nekton populations by means of large trawl nets revealed that the number of fish, fish species and nekton decreased on the nearshore shelf as both Production Platform 54A and the drilling rig was approached. Similarly, biomass and species diversity were much lower than at more distant sites. The production platform site yielded 2.75 times fewer fish than did the control for an equal number of samples. Drilling rigs had ". . . a disruptive effect on bottom fishes as compared to an area where there were none." This phenomenon was even more evident in Timbalier Bay as manifested by the absence of the majority of the fish species. Perry contends that the low number of fish "is a result of the overboard discharge of large amounts of barium-rich drilling mud and solution" so that the bottom surrounding a platform becomes very compacted and the normal infaunal invertebrates, a prime food source for the demersal fish, are excluded. In lease tracts with heavy drilling pressure, such a situation could become detrimental to the welfare of a considerable amount of viable offshore bottom-land for a considerable time. The commercial fishery consumed by man from the subtidal Louisiana Shelf is composed almost entirely of demersal or bottom-associated fish and shrimp feeding largely on benthic invertebrates, rather than the pelagic species that are ubiquitously shown in colorful oil industry ads associated with oil rigs giving the obvious implication that oil industry activities are not deleterious but actually beneficial to the fishing industry.

Perry's investigations were closely complemented by a similar sampling program by Waller (GURC/OEI, 1974) on the invertebrates, both infaunal and epipelagic, using trawls and bottom grabs. Offshore results essentially duplicated Perry's findings from demersal fish. Catch per unit effort by trawls and density per Van Veen grab were very much greater at the control site than at Production Platform 54A or downstream from the Drilling Platform. The same trends, although less pronounced, were evident in Timbalier Bay. Waller concludes that "Invertebrate catches show a rather bleak picture of what is apparently happening around long-term production rigs if 54A is to be considered an 'average' production operation." He also underlines a crucial deficiency in the GURC/OEI by pointing out that "We do not have associated data concerning hydrocarbon and toxic heavy metal concentrations (from drilling muds) and these data will be quite interesting coupled with catch information."

Farrell, alone, among the benthic workers in the GURC/OEI had no doubts or qualifications about his conclusions, the sampling program, or the validity of the control stations used. Yet, it is his version of no detrimental effects from producing oil wells on the benthic fauna either on the shallow Louisiana Shelf or in Timbalier Bay that most approximates the interpretation found in the Consensus Report and provides the basis for the claims of 'good ecological health' made by the Industry.

The 'health' of a faunal community is most commonly ascertained through diversity measurements. High diversity values are indicative of 'healthy' low stress environments and low diversity values are the products of high stress conditions that are either naturally occurring and/or man-induced (Pierson and Rosenberg 1976). Farrell applied diversity measurements to the mollusc and crustacean components of the biota in Timbalier Bay and the study area on the Louisiana Shelf. Despite the fact that the individual quantitative Van Veen bottom sampler took a bottom sample of 0.2 sq. m., both the number of individuals and number of species of these two groups were meager. This, in itself, should be a source of concern. However, instead of obtaining diversity measurements on individual samples, he combined or pooled all samples taken at a given station over the entire study. His rationalization for such a procedure was "To eliminate sampling error and natural variation from the calculation of index measurements . . . ." In another set of measurements, the infaunal Van Veen grab samples were combined with a very different set of samples taken with the Small Benthic Trawl which moved over the bottom for an undetermined distance and, unlike the quantitative Van Veen grab, selectively sampled benthic invertebrates living on rather than in the bottom.

We can find no statistical justification or precedence in the extensive published literature to support Farrell's combining an entire set of samples from a given station that were collected on different dates and seasons, nor for his pooling of quantitative primarily infaunal samples with non-quantitative, largely epifaunal samples. Each individual sample must be treated separately and only samples collected in an identical manner can be validly compared.

Even when the pooled samples were restricted to those taken with the Van Veen or Small Benthic Trawl, Farrell's analyses remained grossly invalid. Seasonal compositional changes in the benthic fauna were large. Farrell observed that "None of the Louisiana sampling sites can be characterized by a molluscan or crustacean species throughout the sampling period" (1974a, p. 9).

Thus Farrell's calculations of diversity from combined individual samples and samples taken at different times of the year when species were only seasonally present or occurred in markedly different numbers must artifically increase both species richness and equitability, the two components of diversity indices, by decisively increasing the number of species included in the analysis and homogenizing or evenning out the large differences in species composition. The false products of such artifacts are exaggeratedly higher diversity values.

Despite the invalidity of Farrell's analyses, diversity values 'remained relatively low' for the pooled grab samples, even when they were combined with trawl samples. The species diversity in Timbalier Bay for ". . . the Van Veen samples were low (0.328-1.847). . . The platform station was slightly more diverse than the control (0.578-0.727). Inclusion of SBT samples in the calculations increased values at all stations, but, with the exception of Station 4, species diversity remained relatively low" (Farrell, 1974b, p. 2).

The three intensively sampled stations on the nearshore Louisiana Shelf yielded somewhat higher, although still modest, diversity values for the pooled Van Veen samples - 2.448 for Production Platform 54A, 2.340 for its control and 0.429 for the muddy-sand station with its abundance of Mulinia lateralis. However, even if the pooled samples for the production platform and its control were, in reality, discrete single samples for each of the stations, the diversity values found would still not be valid. The number of crustacean and molluscs present were still so low at Production Platform 54A (8 pooled samples; 73 specimens per 1.6 m^2) and its control (10 pooled samples, 145 specimen per 2.0 m^2) that the fauna remained undersampled and the inherent dominance was not realized, resulting in greater equitability and therefore higher apparent diversity (Sanders, et. al., 1980). The fundamental weakness in Farrell's GURC diversity studies is that he grossly undersampled the benthic fauna.

Yet, after manipulating the data in a variety of unacceptable ways that served to increase diversity, Farrell's ultimate diversity value still ranged from low to very low: by combining samples to obtain a single diversity measurement; combining samples collected at different times of the year, which both hides the significant seasonal differences in species composition and density and gives invalidly enhanced species richness; and combining quantitative with qualitative samples taken with different sampling gear that select very different components of the fauna and thus defying any possible intercalibration among the stations. We are unable to fathom how his studies purport to show good environmental health for the benthic fauna of these active oil field study areas.

Although the analyzed component of Kritzler's carefully detailed investigation of the polychaete fauna of Timbalier Bay represents only a fraction of the samples he collected, these were the only samples among the various GURC/OEI benthic studies with sufficiently large enough numbers of species and densities per sample so that the biota was not obviously undersampled. Such undersampling, at best, compromises the validity of statistical indices used to interpret such aspects of the benthos as diversity, faunal similarity and even species composition. In addition, the wide differences for polychaetes reported by Kritzler and Farrell taken at essentially the same times at the production platform station and its control in Timbalier Bay in 1973 raise disturbing doubts. Screens with 0.5 mm mesh openings were used to wash the samples in both studies. Farrell did not count the overwhelming numerical dominant, Spiochaetopterus oculatus. The total polychaete densities per square meter excluding Spiochaetopterus for the winter, spring and summer of 1973 at the production platform station found by Kritzler and Farrell respectively were 204 and 70, 574 and 70 and 413 and 105, representing densities that were 2.9, 8.2 and 3.9 times larger in Kritzler's as compared to Farrell's samples. Similarly, densities for the control station for the same three seasons of 1973 were 527 to 1115, 624 to 105 and 579 to 80, or density ratios of 0.47, 5.9 and 7.2 between the Kritzler and Farrell studies. Such a large magnitude of disparity in studies that should have shown a near identity of results must inevitably challenge the credibility of one or the other of these studies.

Kritzler made the interesting observation that ". . . the polychaetes in Timbalier Bay, with few exceptions, are very small, individuals of many species being very much smaller than their counterparts in other places such as the sandy habitats of the Apalachicola River delta (Florida)." He attributes their diminutive size to intensive predation. However, Michael, Van Raalte and Brown (1975) also pointed out the small sizes of the benthic animals at the intertidal stations in the Wild Harbor River estuary where oil residues were still present in the sediment in 1973 and 1974, four and five years after the FLORIDA spill (as was also true at shallow subtidal station 31) as compared to the same species present at the control locality in nearby Sippewissett Marsh which remained unoiled.

Many of the species have a life span of a year or less. Since the only obvious difference between the two study areas was the occurrence of petroleum hydrocarbons in the sediments in the Wild Harbor River estuary, then the oil residues must be considered as the causative stress for reduced growth rates found at the Wild Harbor River stations.

Physiological stress is manifested in higher energy demand. The soft-shelled clam, Mya arenaria, and two species of mussels living in sediments contaminated with petroleum hydrocarbons showed changed carbon flux (Gilfillan, 1975; Gilfillan, et. al., 1976). The higher the concentrations of petroleum hydrocarbons, particularly of aromatics, the higher the metabolism, the lower the rate of assimilation, the slower the growth, and the lower the fertility. In a comparison of two populations of Mya of a chronically oiled lagoon with a non-oiled lagoon showed that there were fewer mature adults, a one- to two-year lag in tissue growth, a lower rate of shell growth, a reduced carbon flux and a lower assimilation rate as a result of six years of continued stress following the ARROW spill in Chedabucto Bay, Nova Scotia (Gilfillan and Vandermeulen, 1978). There has almost certainly been continuous chronic pollution from oil industry activities during the last four decades in Timbalier Bay. As evident from the studies in Chedabucto Bay, Nova Scotia and in North Falmouth, Massachusetts, we suggest that the very small sizes of the polychaete species in Timbalier Bay are a response to petroleum hydrocarbons rather than being the postulated product of intensive predation. The fact that no information is available on the concentrations of petroleum hydrocarbons in the sediments of Timbalier Bay and the study area on the Louisiana Shelf points out once again the profoundness of its omission in the GURC/OEI Investigation.

Kritzler believes that ". . . the relatively large numbers of polychaete species found thus far in the Bay as a whole, and the substantial numbers turning up in individual samples suggest that the bottom of the Bay is a healthy one" (p. 13). He qualifies this statement in his next paragraph, "If the controls selected by the Program Planning Council at the outset are good ones, one is led to the conclusion that long term oil production and drilling in Timbalier Bay has not exerted demonstrable stress on the polychaete taxocenosis. His doubts concerning the validity of the controls have been discussed. In addition, both the density and faunal similarity indices revealed greater similarity between the control for Production Platform station and the Drilling Platform, on one hand, and between the control for the Drilling Platform site and the Production Platform, on the other hand, clearly demonstrating the inappropriateness of the controls selected by the Program Planning Council.

Kritzler contends that the polychaetes are especially useful in studying impacts from petroleum pollution "Because assemblages of polychaete species have been shown to serve as indicators of sewage and industrial pollution (Reish, 1955, 1959), it is thought that they might also show the effects of long term oil production and drilling." The single most dramatic aspect of the polychaetes in Timbalier Bay was the overwhelming numerical dominance of a single species, Spiochaetopterus oculatus, which formed nearly 84 percent of this fauna. As discussed previously in this paper, Wade and colleagues documented the deterioration of the environment and benthic fauna from 1968 through 1974 in Kingston Harbor, Jamaica such well documented observations, makes it difficult to accept Kritzler's interpretation ". . . that the bottom of the (Timbalier) Bay is a healthy one."

His other basis for the good health of Timbalier Bay was ". . . the substantial numbers (of polychaetes) turning up in individual samples. . . ." We compared the densities per square meter between the polychaetes found in Kritzler's Timbalier Bay samples with the polychaete densities obtained at the intensively sampled stations in the West Falmouth study. Since 0.3 and 0.5 mm mesh size sieves were used, respectively, to process the West Falmouth and Timbalier Bay samples, and calibration studies undertaken by scientists at the Marine Ecosystems Research Laboratory (MERL) at the University of Rhode Island found that at two different stations a 0.3 mm mesh retained 1.71 percent 0.24 and 2.25 percent 0.81 times as many benthic animals as did an 0.5 mm mesh, we will multiply the polychaete densities reported by Kritzler by a factor of two. We will then apply the Mann-Whitney U Test (Siegel 1956) to test the null hypothesis that the polychaete densities in Timbalier Bay were not significantly different from those in the area affected by the FLORIDA oil spill in Buzzards Bay, Massachusetts. Kritzler's 16 analyzed samples are then compared with the samples taken at each of six intensively studied subtidal stations that were sampled for periods of from 18 to 41 months in the West Falmouth study - minimally oiled stations 5, 20 and 35, stations 9 and 10 that were intermediately oiled, and severely oiled station 31. The comparison will be made for the total polychaete faunas and with the single most numerous polychaete species excluded (Spiochaetopterus oculatus in the Timbalier Bay samples, Mediomastus ambiseta at stations 5, 9, 10, 20 and 35 and Capitella capitata at station 31 in Buzzards Bay).

The mean densities were always higher for the Buzzards Bay stations with the single exception of the total polychaete comparison where the mean density for Timbalier Bay was slightly larger than for severely oiled station 31. The null hypothesis can be rejected in 8 of the 12 comparisons at probability values of less than .002 the maximum level of significance tested, and in one comparison at $p < .02$. The three remaining comparisons were not significantly different at $p < .10$. Two of the three probability values greater than .10 were with the two comparisons between the Timbalier Bay and station 31 (total densities and densities with the single most abundant polychaete species excluded). Station 31 continued to be severely polluted by oil residues from the FLORIDA spill throughout the 41 months of our study (Sanders, et. al., 1980) and remained heavily polluted in the fourth and fifth years after the spill

(Michael, Van Raalte, and Brown, 1975). Throughout this entire period of study, the fauna at station 31 was highly variable with abrupt and dramatic changes in density and faunal composition from one sampling period to the next. The fauna at station 31, as in Kritzler's samples from Timbalier Bay, were composed of unusually small specimens.

The remaining pairing that yielded a p value greater than 0.1 was with intermediately oiled station 9 for the total polychaete fauna. The polychaete densities were greatly reduced in the aftermath of the oil spill and very low densities persisted throughout the entire first year. The last comparison, giving a p value < .02, was for the total polychaete faunas of Timbalier Bay and intermediately oiled station 10. The benthic fauna at station 10 remained markedly depressed during the first year of study but not to the degree found at station 9.

Thus, the Timbalier Bay polychaete densities were very significantly smaller than were densities obtained from the FLORIDA oil spill study except at those sites where the sediment continued to be heavily impregnated with oil throughout the study period or where the densities of benthic fauna remained very reduced for a year following the spill. This analysis places doubt on Kritzler's contention that the supposed ". . . substantial numbers (of polychaetes) turning up in individuals samples. . ." are evidence of the good health of Timbalier Bay.

Summary of the Offshore Ecological Investigation. This review of the final reports of the principal investigators has revealed a large number of major flaws that have totally eroded away the highly publicized and widely distributed interpretations in the Final Consensus Report. The report is supposedly based on these same sources of information and it purports to show that no adverse effects have resulted from more than thirty years of oil industry activities.

The Consensus Report makes no mention of the doubts and misgivings articulated by a number of the principal investigators about the validity of the control sites chosen both in Timbalier Bay and on the nearby Louisiana Shelf of the GURC/OEI study area. Nowhere in any of the reports of the principal investigators nor in the Consensus Report are locations of the production and drilling platforms on the Louisiana and near Texas Shelf or in Timbalier Bay given. Without such information, it is impossible to measure the validity of the selected controls.

Because they are navigational hazards, the positions of offshore platforms appear on navigational charts. We counted 2,600 platforms that were continuously present along the Louisiana and near Texas Shelf. Such a number represents a minimum figure. Data on current speed document the short transit time between the production platform and its control site 9 kilometers away and the only slightly greater distances between numerous other active platforms and the control location. Extrapolation of the frequent incidences of low-level pollution events documented at Production Platform 54A on the Shelf and the Philo Brice Platform in Timbalier Bay to the thousands of other active platforms reveals that the entire inner shelf of Louisiana and part of the adjoining Texas Shelf is uniformly contaminated with petroleum hydrocarbons. The findings in most of the studies, particularly in the water column, showing no differences between the production platform and its control are not, as stated in the Consensus Report and a number of individual studies, evidence that there have been no adverse effects of oil extraction operation but, instead, they are manifestations of uniform pollution of the entire inshore shelf of Lousiana from oil industry activities.

Based on laboratory studies that optimize degradation rates of petroleum by bacteria, a model is proposed stating that degradation of petroleum by bacteria in the waters of the Louisiana Shelf equals the rate at which oil is being released through chronic discharge to regulate the concentrations of petroleum hydrocarbons so that they are kept in dynamic equilibrium throughout the entire inner shelf of Louisiana. Yet, the extreme concentrations of nutrients used in the laboratory to activate this rate of degradation are impossibly greater than can be achieved under natural conditions. Furthermore, even under these idealized laboratory conditions, the aromatic hydrocarbons, as reflected in the unresolved envelope of the gas chromatogram, are hardly altered. In the Consensus Report, the limitations of the model are not mentioned and the model itself is barely referred to. There we learn that hydrocarbons discharged through oil industry activities on the Louisiana Shelf are being degraded as rapidly as they are released.

One of the integral components in oil pollution studies as verified in a number of investigations, is the often rapid transport of spilled oil from the water column onto the seafloor and into the bottom. Its total exclusion in the GURC/OEI report must represent a critical omission that seriously compromises the entire study. It is inexcusable that the function of bottom sediments as sinks for spilled oil is not even mentioned in the Consensus Report. We do know that total hydrocarbons in the sediments in the GURC/OEI are very high, at levels that have been shown to be lethal or stressful in the West Falmouth study. However, unlike the West Falmouth investigation, the petroleum-derived hydrocarbons were not separated from naturally occurring hydrocarbons. It is inexplicable that this crucial separation was not undertaken since the stated fundamental objective of the GURC Offshore Ecology Investigation was to determine what impact oil industry activities were having on the marine biota.

Since primary production in the GURC/OEI study area is among the highest found in the Gulf of Mexico and the water depths there are shallow, one should expect large populations of benthic animals in the absence of significant stress conditions. When compared to densities found in other benthic studies in European and North American waters, the densities reported for the GURC studies were very reduced. Despite the allegation that species present in the GURC/OEI are indicative of a 'healthy' benthic environment, most of the bottom living animals collected were composed of two highly opportunistic species that have been shown in other studies to be indicators of significantly stressed environments.

The one benthic investigator who put no qualifications on his conclusions nor raised questions about the sampling program or the controls was also able to unequivocally state that there has been no detrimental effects from oil industry activities on the benthic fauna. It is his version that most approximates the interpretation found in the Consensus Report and must provide the basis for the claims of 'good ecological health' made by the oil industry. However, he had manipulated his data in a variety of unacceptable ways that falsely produced exaggeratedly higher diversity values and thus 'greater ecological health.' What is further disturbing, is the very wide quantitative differences found between his and another GURC study for the same animal group that were sampled at the same times and at the same stations.

The Offshore Ecological Investigation, 1979. Recently, Volume 53, Nos. 4 and 5, 1979 of the Rice University Studies, devoted exclusively to the Offshore Ecology Investigation, has become available. The entire contribution comprises 589 published pages and includes the following sections: Introduction, Methods and Summary Results, Research Reports of the Principal Investigators and an Independent Appraisal of the OEI by Bender, Reish and Ward who were also the editors.

It is impossible, within the available time for submission of this paper to the Marine Board to carefully and critically review these 1979 versions of the GURC/OEI Principal Investigators Final Reports and/or attempt an in-depth critique of the Independent Appraisal by Bender, Reish and Ward. A cursory and superficial overview indicates that changes have, indeed, been made in a number of the 1979 versions of Principal Investigator Reports as compared to the original reports written in 1974. Yet, whatever these modified versions do state, the interpretations presented in the Final Consensus Report have been aggressively and effectively used to influence decision-making and policy. The Consensus Report in turn is purportedly based on the 1974 Final Reports. Since the Principal Investigator Reports were not readily accessible, it was no easy task to ascertain the soundness of the scientific information in the individual reports of the Principal Investigators, nor to determine what information in the separate reports was included in the Consensus Report and what information was omitted. For this reason, their inclusion in the Rice University Studies publication is most welcome. However, where differences do occur between the original and 1979 versions of the same Principal Investigator's Report, these differences should be clearly brought to the attention of the reader together with the rationale for the changes.

What was particularly obvious from this very cursory overview, was the absence of any of the hydrocarbon data presented in the 1974 Final Report by Laseter and Ledet in the 1979 version. Their report should represent the critical cornerstone study upon which most of the other studies are dependent. This becomes particularly vital since the study by Laseter and Ledet provided the only data on hydrocarbon concentrations in the bottom sediments, a major sink for petroleum discharges into the overlying water. One can appreciate the possible reluctance of Laseter to present data taken at a time when techniques for separating petroleum-derived from natural occurring hydrocarbons were not yet widely used. They were, however, employed with considerable effectiveness in the earlier West Falmouth study. What must be particularly difficult for Laseter is the fact that for the last number of years he has been on the forefront in developing greatly improved chemical analytical techniques to quantitatively and qualitatively measure the diverse components of hydrocarbons in the marine environment. Thus, he could readily provide, with considerable precision and competence, the quality of hydrocarbon data that was so obviously lacking in the GURC Offshore Ecology Investigation.

A Brief Perusal of the Independent Appraisal of the Offshore Ecology Investigation of Bender et. al., (1979). These authors concur with the conclusions drawn earlier in this position paper that the control sites were invalid. "The OEI data do not support a conclusion of 'no effect' where the validity of the comparisons between platform and control sites is dependent on there being a difference in hydrocarbons present. Rather, it appears that most of the OEI data was collected from the same 'population' and should be expected to be the same within statistical errors of sampling. In addition, great temporal and spatial variability of data on specific species, coupled with the probability of the Gulf being 'completely mixed' with reference to hydrocarbon content, probably prohibits utilization of classical experimental versus control design concepts" (pp. 36-37). They cite the doubts voiced by the Principal Investigators about the adequacies of the controls that include many noted previously in this position paper which were never aired in the Consensus Report. Bender, et. al. believe ". . . that the OEI Council conclusions (Morgan, et. al., 1974) should be reviewed and restated to indicate clearly the limitations of the experimental design and the data base for definitely answering questions on chronic effects of oil" (p. 38).

A quick overview of the re-examination of the OEI revealed that Bender and colleagues did not consider the appropriateness of the model for the waters of the Louisiana Shelf. They stated that degradation of petroleum by bacteria equals the rate at which oil is being released by chronic discharges which keep concentrations of petroleum hydrocarbons in a balanced equilibrium. They also failed to comment on the total omission in the OEI of the critical transport of spilled oil from the water column onto the bottom. They obliquely refer to this major shortcoming by mentioning in their conclusions concerning the OEI data base that "Programs designed to detect the presence or effects of petroleum hydrocarbons should have as a primary component of the experimental design the most advanced analytical support for quantifying hydrocarbons in the most likely sinks, especially in sediments and organisms" (p. 97). They do observe that "there were insufficient sediment samples analyzed for hydrocarbons in the OEI to assess adequately buildup or possible effects on benthic organisms" (p. 96). Bender, et. al. concur with the major conclusion in the Consensus Report that every indication of good ecological health is present. They base that concurrence on the fact that the study area has one of the highest rates of primary and secondary production in the Gulf of Mexico and that it is an extremely organic-rich marine environment. Furthermore, they believe that ". . . if there had been a buildup of hydrocarbons or other pollutants, then one would expect a reduced benthic fauna and the appearance of pollution-tolerant species, such as Capitella capitata, in large numbers at the affected localities," a condition they believe that is not borne out by the OEI benthic studies. Our own analysis refute their interpretation by showing that despite the organic-rich ecosystem, the benthic fauna is, indeed, decidedly reduced relative to densities found in other studies and that the majority of the benthos in the OEI study area is composed of two species, both of which have been documented as precise indicators of severely polluted environments.

In their appraisal, Bender, et. al. do not question the manipulation of data in unacceptable ways in one of the benthic studies that falsely create exaggeratedly high diversities that, in turn, support the contention of 'good ecological health.' They uncritically accept and use data in their appraisal, as, for example, certain nutrient concentrations, that are orders of magnitude higher than what any chemist would expect to find.

I must emphasize that these remarks regarding the independent appraisal of the Offshore Ecology Investigation by Bender, Reish and Ward are immediate observations made from a brief perusal of their paper. Their efforts deserve a careful, detailed and thoughtful critique.

The Ekofisk Oilfield Study

The question must be asked as to what conceivable meaning has a fate and effects study of possible oil pollution resulting from oil extraction off the Louisiana Coast if such a study was carried out 34 and 35 years after operations were started? If marked changes had occurred, they almost certainly would have been initiated at the advent of oil exploitation and become evident mainly within the next few years. As with the GURC Offshore Investigation, the few attempts to measure such impacts were nearly always done many years after this critical early period of operation.

Fortunately, there has been an investigation of the Ekofisk oilfield by Addy, Levell and Hartley (1978) which does provide information of some effects that can occur during the first few years of oil industry activities. The initial survey was done in August

1973 almost concurrently with the start of extraction operations (Dicks, 1975) and was repeated again in August 1975 and August 1977 (Addy, et. al., 1978). Twenty-four stations were occupied. They were arranged in a series of radiating lines or transects from a storage tank and two nearby production platforms. The total area covered was approximately 126 square kilometers with the most remote stations approximately six kilometers from the central storage and production complex. Faunal, hydrocarbon and sediment samples were collected at each sampling site.

The first survey revealed no significant differences in community structure among the stations. The sediments, composed of fine sands, were remarkably homogeneous throughout the study area and water depths only varied between 67 and 71 meters (Dicks, 1976). By 1975, some reduction in total densities were noted close to the storage tank and Production Platform B. In 1977, the area of low faunal densities had spread and at the innermost stations there was further pronounced decreases in species, total densities, and densities of numerous individual species relative to stations more distally sited along the radiating transects. At the same time there was a large increase in hydrocarbons in the sediments closer to the storage and production facility as compared to the sediments from the more distant stations. Concentrations of organic extractables were high near the storage tank and Production Platform B. The concentrations of aromatic hydrocarbons were much higher at the innermost stations and the unresolved envelope of gas chromatographs, representing the amount of degraded hydrocarbons, were again highest in the analyses of stations closest to the installations. Finally, the ratios between the straight-chain paraffin molecules n C_{18} to n C_{29}, which measures the quantities of undegraded crude oil and naturally occurring hydrocarbons respectively, were highest around Production Platform B. These benthic faunal and hydrocarbon data clearly document the chronic low-level pollutional effects of oil industry activities on the benthic fauna in the critical early period of operation in a new oilfield.

Addy and his colleagues appear to have carried out a sound and valid investigation that cleanly documents the adverse effects of oil exploitation during the first few years of operation when the chronic impacts were becoming manifest. Yet, we should be cautious in making universal generalizations at the present stage of our limited knowledge from this one important study. Hartley (in press) a co-investigator in the Ekofisk oilfield research program, carried out a similar investigation in the Forties oilfield in the North Sea using procedures and analyses comparable to those employed in the Ekofisk surveys. A pre-operational survey was made and a survey was carried out three years later in June 1978. Little change could be detected in either densities or species composition. Sediments and water depth were much more variable in the Forties as compared to the Ekofisk study area and faunal differences that were found could be related to differences in sediment composition and/or water depth. Hydrocarbon concentrations present in the sediments were low throughout the Forties oilfield study area.

Chronic Exposure to Petroleum from a Natural Seepage of Oil

Finally, I would like to consider briefly the study by Straughan (1976) of a natural seep of oil at Coal Oil Point, near Santa Barbara, California. Her study, together with the GURC Offshore Ecology Investigation are cited by Mertens (1976) to show that "Low-level chronic exposure to crude oil has, at most, negligible effect on marine life." Straughan's final report submitted to the American Petroleum Institute's Environmental Affairs Department is claimed to be the most definitive, careful, detailed, scientifically documented investigation ever undertaken on sublethal effects on natural chronic exposure to petroleum in the marine environment.

At Coal Oil Point there is a natural oil seepage that is releasing oil into the water at the rate of 50-100 barrels per day. The seepage has been known and active for many years. The key question to be determined, then, is whether there are any differences b[illegible] the abundances or the presence and absence of benthic species i[illegible] the chronically oiled sediments at Coal Oil Point as compared to unoiled control sites in the same regional area.

The analytical techniques used to answer this question were normal and inverse classification dendrograms with resultant two-way tables. The actual data upon which these dendograms were based were never presented in the report. The rationale for the procedures employed are as follows (pages 46 and 48): "The relationship between species groups and site groups for all species was based on both co-occurrence of species and numerical equitability (Figure 19). Species were standardized by total prior to analysis. This facilitated comparison of abundance values for particular species within their range of abundance, e.g., if the highest number of the brittle star, Amphioda urtica in any box core was 100, then 5 in a box core was recorded at 5 percent; at the other extreme, if the highest number of the echiuroid worm, Listriolobus pelodes, in a box core was 2, then 1 in a box core would be recorded at 50 percent. This standardization permits inter-sample comparison of abundance but not interspecies comparisons of abundance."

It would seem straightforward to obtain the actual abundances of any species in the individual samples by reversing the standardization procedure. For example, if species A appeared in 25 of the 82 samples taken during the Coal Oil Point Study and the standardization values in these 25 samples in regard to the maximum density of species A found in an individual sample were 100, 80, 75, 60, 55, 45, 35, 25, 20, 15, 15 15, 10, 10, 10, 10 5, 5, 5, 5, [illegible], 5, 5, and 5 then the actual densities would be 20, 16, 15, 12, 11, 9, 7, 5, 4, 3, 3, 3, 2, 2, 2, 2, 1, 1, 1, 1, 1, 1, 1, 1 and 1 per sample. Yet, when I tried to interprete the standardized percentages in this manner, I was, in most cases, unsuccessful. Some of the problems encountered are illustrated with the following polychaetes.

Prionospio pinnata was present in 11 of the 82 samples. It appeared 8 times at 71 percent and 3 times at 100 percent. Nephthys caecoides occurred in 12 samples; 9 times at 71 percent and 3 times at 100 percent. Glycera capitata was found in ten of the samples; 8 times at 58 percent, once at 82 percent and once at 100 percent. Thallenessa spinosa was collected in 17 samples; 12 times at 45 percent, 2 times at 63 percent, 2 times at 77 percent and one time at 100 percent. I can find no integer that satisfies the transformation percentages for any of the four polychaete species.

Furthermore, a very significant fraction of the 68 polychaete species included in the Normal and Inverse Classification Dendrogram -.27 species or 39.7 percent of the species -- have transformation values of only 100 percent. In other words, nearly 40 percent of the species included in this analyses are represented by a maximum density of one individual in any of the samples. At such low densities the presence or absence of a species is due to mere chance. Therefore, it is not surprising that a random pattern emerges when the Coal Oil Point and the unoiled or low-oiled control site samples are compared. Yet, what was cited as one of the most significant results of Straughan's Coal Oil Point Investigation, that "There was no relationship between abundance or presence/absence of any group of organisms and petroleum hydrocarbons in sediments." (p. iii), was, instead, an artifact of the apparent extremely low densities of many of the species included in the analysis that must inevitably yield a random pattern.

Also disconcerting, on the basis of my interpretation of the transformed data, was the absence of the expected normal or truncated normal distribution pattern for any adequately sampled species in the case of each of the 68 polychaete species used in the analysis. There were very few cases where standardized percentages occurred in the 1 to 34 percent range while larger standardized percentages were significantly more common. This suggests an absence of single, two or three representatives of a species in samples when the maximum density found for that species is high. Such patterns are strikingly different from anything I have seen.

Subsequently, in December 1977, I wrote Dr. Straughan about my concerns and asked for the raw sample data--that is, the composition of various species in each sample and the actual number of individuals in each species. It may be, I observed in my letter, that I had misconstrued her methodology.

A few weeks later, Dr. Straughan replied: "You cannot deduce actual numbers of specimens from the dendrograms. The data show relative abundance for a particular species in each sample. The way it is presented also does not provide 'between species abundance comparisons.' We are currently reworking these samples and trying to complete identification of all groups. When this is complete, we should be in a position to provide raw data."

It is not certain that Dr. Straughan's work on the Coal Oil Point data has been completed, though it continues to be cited by some as a possible basis for policy and decision making in connection with the ocean environment. Considering the uncertainty of the data in this case and the inconclusive evidence of the GURC Offshore Ecology Investigation, the concerns of many scientists about the adverse effects of petroleum on marine species need to be seriously considered. No one is certain at what concentrations in the ocean petroleum is dangerous to organisms, but there is no question that it causes scientific anxiety.

Howard L. Sanders is an ocean scientist with Woods Hole Oceanographic Institute, Woods Hole, Massachusetts. Dr. Sanders is an expert in benthic ecology.

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STATUS OF INFORMATION ON THE ENVIRONMENTAL EFFECTS OF OCS PETROLEUM DEVELOPMENT

by

Fred T. Weiss

This note attempts to bring together certain salient points relating to Outer Continental Shelf (OCS) petroleum activities. The 1975 report issued by the National Academy of Sciences entitled "Petroleum in the Marine Environment" presents a thorough review of information available at that date on the fate and effects of petroleum on the marine environment.[1] That report represents a consensus of some 60 practicing scientists from many academic institutions, governmental agencies, and industry. Since the time of publication of that Academy report, more quantitative data have become available but the basic conclusions and the implications still are correct. Since the report is widely available and fully detailed, the issues relative to the effects of OCS petroleum development in the marine environment can perhaps be addressed by reference to pertinent sections of that report.

Validity of Data. On page 105 of the report, it is concluded that "There is a need for accurate, standardized techniques for chemical analysis and for biological studies." The purpose of development and use of standard methods with recognized levels of precision and accuracy is to be able to judge the effects of pollutants on the environment. This need has been met to a considerable extent in the major scientific studies on petroleum in the marine environment. For example, the Bureau of Land Management has funded recognized quality control centers for the data obtained in its programs. The American Society for Testing and Materials Committee D-19 on Water has a wide membership from many locations concerned with these questions and issuing consensus methods. Industry and government agencies have responded well to this need. Less response has come from academic institutions whose funding does not always bring them into consensus method programs.

"Peer Review" Publications. There is a recognized series of quality publications for scientific material. The best quality publication is recognized where thorough review is made by "peer" scientists prior to acceptance of the article. A lower level will be from symposia whose organizers utilize a screening procedure, sometimes including a peer review. A large fraction of information is currently issued as reports from government agencies, trade associations, or academic institutions forming the so-called "gray" literature. The need to upgrade the level of publication, and to provide time and funding for that purpose, is widely recognized. In fact, the Bureau of Land Management's Outer Continental Shelf Scientific Advisory Committee has recently made this recommendation to the Secretary of the Interior.

However, such a large fraction of current information is only available in the "gray" literature that it cannot be ignored. In fact, an appreciable fraction of the references in the Academy report are of this nature. That report could not have been properly completed without a number of unpublished manuscripts and reports from leading institutions such as National Marine Fisheries, Woods Hole Oceanographic Institution and the U.S. Geological Survey.

Effect of Petroleum on Health. Page 106 of the Academy report concludes that "although our information is limited, the effect of oil contamination on human health appears not to be cause for alarm." This conclusion was based on evidence presented on pages 98-99 of the Academy report that amounts of carcinogenic polynuclear aromatics expected from spilled oil would be very low. This is one of the scientific areas in which recent knowledge has increased and we now know that the relative input of polynuclear aromatic hydrocarbons from petroleum is very low. It is now clear that the major worldwide source of polynuclear aromatics (some of which are carcinogenic) is from combustion processes such as coal and coke burning, forest fires and so on. This is particularly well documented in the work of Professor Hites, conducted at Massachusetts Institute of Technology,[2] who shows that polynuclear aromatic hydrocarbons to be found everywhere at part-per-billion levels. The analytical data are clear-cut evidence of a combustion source. A paper[3] presented at a recent American Chemical Society meeting shows that typical polynuclear aromatics are present at very low concentrations even in common terrestrial foodstuffs such as lettuce, cabbage and vegetable oils. The polynuclear aromatics measured at parts-per-billion levels in some marine animal tissues are those derived from common combustion sources and are not from petroleum.[3] These recent data reinforce the earlier conclusions that oil contamination does not pose a risk of adding significant amounts of carcinogenic materials to the environment.

Conflict with Other Industries. One of the concerns generally expressed has been a possible conflict with the fishing industry. This subject was addressed by Dr. John Hunt of Woods Hole, Vice-Chairman of the workshop which produced the Academy report,[1] in his review of the report before the U.S. Senate Committee on Commerce.[4] To quote from Dr. Hunt's statement,[4] "It is clear from the data in Table 1 of our study that oil spilled by offshore drilling is less than 5 percent of the quantity of oil spilled by transporting oil on a worldwide basis. It is an interesting point that there are more than eighty countries in the world today that are actively engaged in

TABLE 1

SIGNIFICANT DATA ON OFFSHORE PETROLEUM SPILLS

Field	Santa Barbara, California	Chevron Block 44, Louisiana	Shell, Bay March-and, Louisiana	Ekofisk North Sea	Campeche Bay, Mexico
Date	January 1969	February 1970	December 1970	April 1977	June 1979
Duration	Four weeks	Six weeks	Four and 1/2 months	Seven days	Eight months
Type and Amounts of Oil Spilled	Medium weight crude oil 33,000 B	Light crude oil 35,000 to 65,000 B	Light crude oil 53,000 B	Light crude oil 90,000 B, plus gas	Light crude oil 30,000 B/D plus gas
API Gravity	24.5	36	39-7	33	-
Fate of Oil Evaporation Recovery	Unknown None	30-50% in 24 hrs. 10-20%	Much oil consumed by burning 21,000 B	50% in 12 hrs. None	Extensive 10%
Distance from Shore	Six miles	Eleven miles	Seven miles	190 miles	400 miles
Amount Reaching Shore	Considerable	Light oiling on one beach climinated by next tide	Minor amounts	None	Some
Environmental Impact	Initial kill of intertidal organisms and birds. Area recovered within year	No evidence of biological damage	Negligible damage to environment	Some low-level fish taste tainting at spill site; none two months later	Some oil on beaches in Padre Island, Texas
References	References (1), (8), (13), (14)	References (11), (12)	References (9) (10), (15)	Reference (8)	Oil and Gas Journal, June 11, 1979, and newspaper coverage

some phase of offshore exploration or drilling. In many of these countries, the fishing industry is a major source of revenue, but there is no evidence to date that the drilling has reduced the level of fishing." A recent review of the British Royal Commission[5] reaffirms that current experience in the North Sea shows that there is no conflict between petroleum development and the fishing industry.

Results of Oil Spill Studies. Pages 74-75 of the Academy report[1] presents a summary table of major oil spills and their biological impact. With but one exception, these are transportation spills. The one accident included was that due to offshore operation in the Santa Barbara Channel in 1969. The report concludes that the Santa Barbara "area (was) recovering well within a year." Data on several offshore petroleum spills are listed in Attachment A. These show a low level long-term environmental impact, even where large amounts of crude oil have been lost. This is due to the fact that much of the light material, which tends to contain the more toxic components, evaporates rapidly. Also it should be pointed out that crude oil is less toxic than the products normally transported by water so that the biological effects are less with crude spills than from products. The Santa Barbara spill was very extensively studied for all types of biota. The review of possible effects on marine mammals is particularly important because of such concern in Alaskan waters. This subject is reviewed in the Interior Department's Final Environmental Statement[6] where it is concluded that "existing data indicate that past petroleum contamination has not had marked adverse effects upon marine mammals within the Santa Barbara Channel."

The most recent offshore spill was that in Campeche Bay, Mexico. Testimony at a U.S. Senate Hearing[7] brought out in detail that the disaster at Campeche Bay would have been avoided by U.S. practices and regulations. A clear-cut picture of environmental impact is still not available.

Chronic Studies. The true test of effects is the study of actual field situations. Three important studies in the petroleum producing area of the Gulf of Mexico have now been concluded and come to essentially the same conclusion: the ecosystems around offshore petroleum operations are normal and healthy; they are not adversely impacted by such operations. These three studies were separately conducted and funded. They are:

1. The study conducted by Southwest Research Institute, funded by the Bureau of Land Management, on "Ecological Investigations of Petroleum Production Platforms in the Central Gulf of Mexico."[16]
2. The study conducted by National Marine Fisheries Service (Galveston), funded by the U.S. Environmental Protection Agency, on "Environmental Assessment of the Buccaneer Oil and Gas Field off Galveston, Texas."[17, 18]

3. The study conducted by the Gulf Universities Research Consortium Offshore Ecology Investigation, funded by a group of petroleum companies, examining Timbalier Bay, Louisiana, during the period 1972-1974.[19]

These three studies--all conducted and funded separately--came to essentially the same conclusion; that environmental impact was minimal.

Indeed, one strong positive contribution of offshore platforms has been observed in the biota not only in the Gulf of Mexico, but also in the waters off Santa Barbara.[20] In each of these locations, marine biologists using scuba equipment have been counting marine species at various depths beneath the platforms and making an extensive photographic record. Where comparisons can be made, the positive biomass contribution of the biota demonstrate conclusively that the effects of oil in the marine environment are far less than the catastrophic effects predicted in some quarters and, further, that such effects are reversible.

As of 1979, the U.S. petroleum industry has more than 30 years; experience in exploration and production of oil and gas in offshore areas. Over 23,000 wells have been drilled in coastal and offshore waters of a number of states including California, Alaska, Texas, Louisiana and, very recently, states along the East Coast. Worldwide petroleum exploration has been carried out in the offshore waters of more than 100 countries, over 50 of which are producing petroleum, are about to produce it, or have made promising discoveries.

Conclusion. The data collected in the past several years completely supports conclusions of the Academy report of 1975 that the impacts of petroleum in the marine environment are not a cause for alarm. There are no long-term environmental damages due to oil spills or due to the low-level input from the operation of the petroleum industry offshore.

Fred T. Weiss is with Shell Development Corporation, Houston, Texas. His discipline is analytical chemistry and he has published several textbooks in that field. Dr. Weiss was chairman of the Chemical Analysis Panel of the National Academy of Sciences' study on Petroleum in the Marine Environment. He is a member of several professional and technical societies, as well as of the Scientific Advisory Committee of the Bureau of Land Management OCS study program.

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DRILL RIG ACCIDENTS

by
Stearns H. Whitney*

Summary

This paper begins with a set of safety definitions, followed by a brief discussion of frequency rates. It then presents a comparison of several data sources in order to establish the validity of the data base to be discussed. This data base consists of the Coast Guard's "Analysis of OCS Drilling Industry Injuries" dated 15 May 1980, a similar analysis made by an insurance company, and IADC's "Charlie" report.

When the data base is established, it will be analyzed to identify the job positions of offshore drilling that contribute to the drilling accident history. Cost will be developed, problem areas will be identified, and recommendations will be made.

Industrial Safety

Definitions

Accident:	An unplanned event that results in harm or loss.
Casualty:	A high value accident. (The value is arbitrarily set.)
Safe:	To be free from an unreasonable level harm or risk.
Safety:	The condition of being safe.

Industrial Safety: A collective term that incorporates the following three definitions:

a. Work Place Safety: The condition of being safe in the general workplace area.

Examples would be:

1. Safety shoes and safety glasses.
2. Non skid decks.
3. Aisle markings.

*The opinions, conclusions and recommendations expressed herein are those of the author and are not to be construed as official or reflecting the views of the Commandant or the United States Coast Guard at large.

4. General machine guarding.
5. Grounded electrical systems.

b. Job Safety: The condition of being safe on the particular job.

Examples would be:

1. Protective hood for sand blasting.
2. Face shield for welders.
3. Grounded electrical hand tools.
4. Machine lock out for repairs.
5. Two hand control for presses.

c. Operational Safety: The condition of being safe during a particular operation.

Examples would be:

1. Blowout Preventer stack.
2. Downhole safety valves.
3. Return fluid degasser.
4. Fire, smoke and gas detectors.
5. Platform emergency shutdown.

Life Safety: A condition of being safe in which the paramount goal is the safety of life during normal or emergency situation.

Examples would be:

1. Vessel integrity.
2. Survival capsules.
3. Structural fire protection.
4. Abandonment training.
5. Emergency position indicating radio beacon.

Frequency Rates

The accident frequency rate is the ratio of the number of accidents to the manhours worked. It is usually expressed as the number of injuries per 200,000 manhours. Sometimes it is expressed in terms of 1,000,000 manhours, but application of a factor of five (5) permits direct comparison of the two systems.

Representative frequencies are shown as follows:

	1975	1976	1977	1978
OSHA (SIC-13)	6.2	6.0	6.3	6.9
LA/OSHA (SIC-13)	6.7	7.2	7.2	N.A.
IADC-U.S. Drilling (Land and water)	-	11.4	10.9	11.6
IADC-U.S. Drilling (Water only)	-	11.8	09.3	09.9
API-(SIC-1311 & SIC-1381)	-	5.1	4.9	4.7

OSHA (SIC-13) - these rates are from the Occupational Safety and Health Administration's annual summary of occupational injuries and illnesses. Standard Industrial Code (SIC) 13 is entitled Oil and Gas Extraction and represents predominately "on land" drilling and production accident rates.

LA/OSHA (SIC-13) - these rates are from the Louisiana State OSHA for the same SIC Code 13. However, it does represent a larger bias towards "over water" oil and gas extraction.

Since both sets of the above OSHA figures represents the total picture of oil and gas exploration, drilling, production, engineering, etc. very low frequency rates in one job classification tend to offset the effect of high rates in a different classification.

For example:

IADC - International Association of Drilling Contractors - is an industrial organization of drilling contractors. Their figures show the average frequency rate for about 154 drilling companies. Their annual "Charlie" report reflects the trend of accidents in the drilling industry as a whole, and in terms of "on land" and "over water" drilling.

API - American Petroleum Institute - is an industrial organization that represents a cross section of the petroleum industry. SIC Code 1311 is for Exploration and Production whereas SIC Code 1381 is for Drilling. The API membership is largely in the area of production. Since production has a very low (about 4) frequency rate, and the 1978 API report shows production manhours to be 22 times drilling manhours, the API frequency rates appear to be very low.

Since this analysis is directed towards offshore drilling, the IADC "Charlie" report provides a sound basis for analysis. The basis is sound because it compares land and water drilling, its frequency rates are consistent with other frequency rates, and it is based on 154 drilling company reports.

The IADC "Charlie" reports were reviewed back to their beginning in 1962. The review showed that from 1962 to 1977 the manhours reported increasd from 26 million to 105 million. The frequency rates for the same period decreased from 14.9 to 9.3. In short, a four fold increased in exposure hours was accompanied by a 38 percent decrease in the frequency rate.

Accident Elements

Staff members of the Coast Guard's Outer Continental Safety Project conducted a survey of offshore drilling contractors to gather detailed accident information. Several companies, selected to represent a cross-section of the industry, permitted examination of their individual initial reports of injury. These examinations resulted in 1954 personal injury reports transcribed in a manner to protect the anonymity of the source while providing useful information.

The information was correlated manually and by computer. The manual correlation was used to verify a recently developed correlative analysis program. Information extracted by computer was then compared to similar information from the "Charlie" reports. These comparisons were necessary because the IADC reports provided general information on some 10,000 accidents while the drilling survey provided detailed information in 1,954 accidents. Since the two reports did correlate well on the order of 65 percent and fairly well on the remaining 35 percent, it was considered that the survey provided representative detail. The comparison of reports is detailed in Enclosure (1).

Final analysis of the extracted industry data resulted in the following items of interest:

a. 76.5 percent of injuries occurred to employees with less than a year on the job.
b. 54.8 percent of the injuries occurred within the first six months.
c. length of tour had no direct relationship to the accident rate; because the greater percentage of accidents occurred during the first to fourth hour and dropped off drastically after the tenth hour.
d. the most common cause of accidents was "caught between" for drill floor personnel.
e. for all other personnel, "struck by" and "fall" were the most common causes of accidents.
f. the absence of personnel protective equipment appeared to be involved in 214 accidents, eye injuries were involved in 113 of these cases.
g. tongs were the piece of equipment involved most frequently in drill floor personnel injuries, with fingers being the most frequently injured body part.
h. of the 1954 injuries, only 130 did not appear to result from the action or inaction of another person.
i. of all job categories, four accounted for 1325 injuries, or 72.2 percent of the total.

Those categories were:		Injuries
Roustabout	-	594
Roughneck	-	471
Derrickman	-	155
Driller	-	105
All other personnel	-	629

An independent analysis of 794 offshore drilling during 1977 and 1978 accidents was performed by an insurance company. The analysis correlated very closely with the Coast Guard analysis. It confirmed that:

a. The majority of accidents involve

Roustabouts
Roughnecks (floor hand)
Derrickman
and Driller job classifications.

b. The rig floor job area is the most dangerous.

The above remarks are illustrated by pie charts in Enclosure (2).

Population Application

The 1954 accident summaries collected by the Coast Guard represented a period of three (3) years. These accident summaries also invclved personnel aboard 20 floating and/or jack-up units. A typical drilling crew including support personnel consisted of 29 people as follows:

6	Roustabouts
6	Roughnecks
2	Derrickmen
2	Drillers
13	Other personnel.

By dividing the number of accidents attributed to a job title by the number of people, the number of units (20), and the number of years (3) under study, one can arrive at a distribution of accidents per person according to job title. These calculations will result in the following figures:

594 accidents for 6 Roustabouts	= 1.65 per year
471 accidents for 6 Roughneck	= 1.31 per year
155 accidents for 2 Derrickman	= 1.29 per year
105 accidents for 2 Drillers	= 0.88 per year
629 accidents for 13 other personnel	= 0.81 per year

Cost Application

An insurance company study of costs associated with 56 cases of injuries and claims cases settled and paid during 1977 and 1978, is detailed in Enclosure (3). Briefly, it shows that typical costs of drill rig injuries are as follows:

Roustabout	-	$2,932
Roughneck	-	$5,938 (Floorhand)
Derrickman	-	$1,435
Driller	-	$1,386
Other	-	$1,909

Expanding these costs to cover a full crew of 29 people yields the following:

6 Roustabouts	= 6 x 1.65 x 2.932	=	$ 29,027
6 Roughnecks	= 6 x 1.315,938	=	46,673
2 Derrickman	= 2 x 1.29 x 1,435	=	3,702
2 Driller	= 2 x 0.88 x 1,386	=	2,440
13 Other	= 13 x .81 x 1,909	=	20,002
Total cost per year		=	$ 101,84[illegible]

Job Hazards

Up to this point, it has been shown that four job categories are involved in 70 percent or more of the injuries and costs of accidents. It is appropriate that those four jobs be described now.

Roustabout: Unskilled labor. The roustabout helps load and unload materials to and from the platform. He handles stacking and delivery of pipe to the drill floor. He also does the painting, cleaning, various odd jobs, and is generally used whenever an extra pair of hands is needed. His work usually involves hands, hand tools and materials. His concern is job safety.

Roughneck: Semiskilled labor. The roughneck usually has had some experience as a roustabout. His prime function is handling tongs and elevators when adding pipe to the string, or when tripping to change bits. He also assists the tool pusher and well service crews during control or treatment of the well. He also assists in BOP installation and maintenance. His work involves hands, hand tools, and heavy items of equipment. His concern is job safety.

Derrickman: Skilled labor. The derrickman is the next step above roughneck. He works on the derrick when adding pipe, or when tripping. He assists the roughnecks when needed. His secondary function, after the derrick, is to maintain the mud system including measuring and mixing mud. His work involves the use of mechanics tools, weighing and measuring equipment, and the handling of mud chemicals. His concern is job and workplace safety.

Driller: Skilled labor. The driller has advanced to his job from the position of derrickman. He supervises the drilling crew and is responsible for well control under the direction of the tool pusher. He operates the draw works, and the catheads. His job requires judgement and skill in operating heavy equipment. His concern is primarily occupational safety in addition to workplace safety.

Entry level personnel: usually the roustabouts and rough necks. They arrive on the rig without skills and are taught on the job. Turnover rate at entry level is extremely high because many found the hard work and long hours unacceptable. These are also the people who work in teams of two to four people to handle heavy loads. In such work, teamwork is essential to safety of people, equipment, and materials; yet, teamwork is a learned skill.

Conclusions

According to the National Safety Council, the three "E's" of safety are Engineering, Education, and Enforcement, in that order.

Engineering is the first approach to safety. Safety problems must be taken into account in the design of equipment, layout of work flow, and development of procedures. This work should engineer nearly all hazards out of the workplace.

Education is the second phase of safety. Training in the proper use of tools, equipment, and materials is essential in reducing hazards that occur because of lack of knowledge or skill.

Enforcement is the last step in a safety program. It is used only as a last resort. Its main purpose is to compensate for a lack of motivation. If companies or people are not motivated to be safe, then enforcement must be used.

Engineering efforts in job safety are presently directed to automating some jobs. For example, an "Iron Roughneck" is under development. It is intended to minimize the handling of drill pipe and tongs.

Entry level personnel are involved in the majority of drilling accidents. They have little or no training, and their work requires a *high degree of manual skills.* These people must work as a team when handling heavy materials and equipment. Manual skills figure predominantly in reducing accidents. In other words, those workers with the least skill are the most likely to be injured. Education appears to be applicable here, particularly if these people could be trained as a team before going offshore.

The annual cost of most drill rig injuries appears to be around $100,000 for the entire rig crew (about 2 days of dayrate). This figure appears to be too low for economics to be a motivation for safety. Lacking an economic motive, it would appear that some definite method of enforcement would promote safety.

It is concluded that the following items require attention:

1. Engineering is presently developing some systems to reduce drill rig hazards.
2. Education of entry level personnel needs to be upgraded. It would be best if personnel were trained as a crew before going offshore.
3. Some method of enforcement must be developed, not to cause the safest companies to be more nearly safe, but to cause the rest of the industry to achieve a higher level of safety.

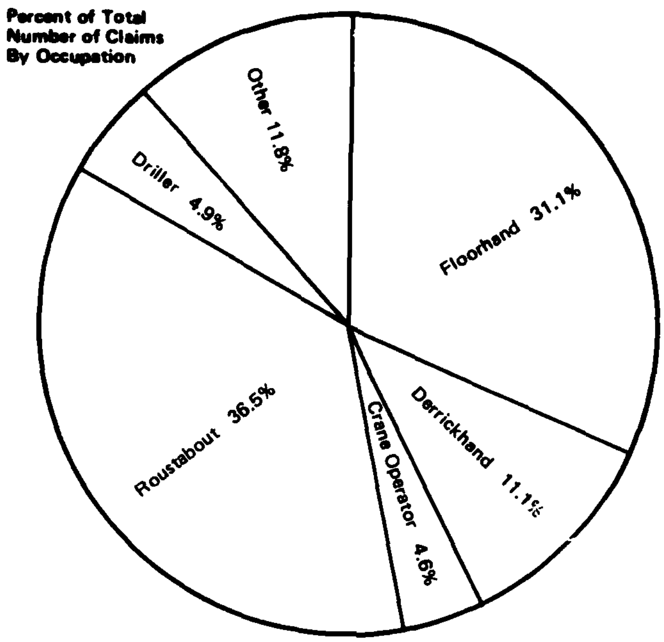
Stearns H. Whitney is a safety engineer with the Outer Continental Shelf Safety Project of the U.S. Coast Guard.

INJURIES

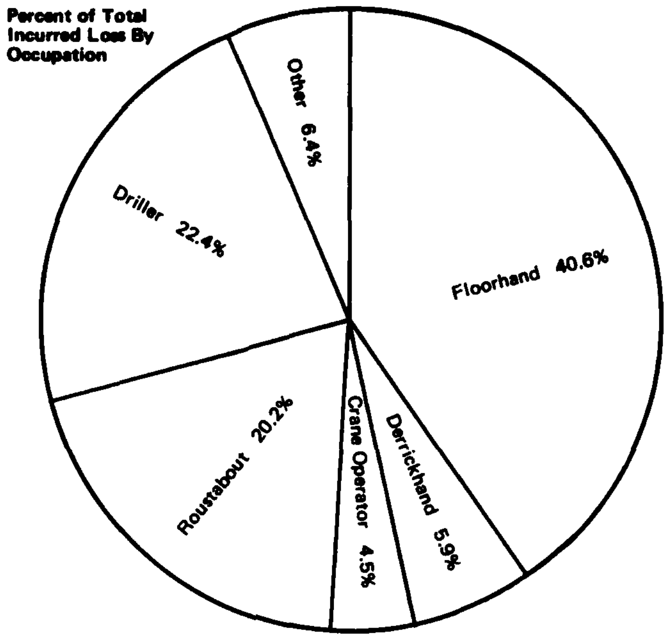
(IADC-USCG Comparisons) (For Same Three Years - 1976-1978)

Cause	IADC Number	IADC Percentage	USCG Number	USCG Percentage	
Struck by Object	527	15.2	401	20.5	
Caught Between Objects	621	18.3	393	20.0	
Falling Objects	227	6.7	110	5.7	Both
Struck Against Object	48	1.4	144	7.4	64.7
Flying Object	94	2.8	178	9.1	
Fall of Person	822	24.2	361	18.5	
Over Exertion	527	15.5	152	7.8	
Machinery and Tools	323	9.5	7	0.36	
Temperature	38	1.1	2	0.10	
All Others	169	5.0	206	10.6	
Totals	3,396	100	1,954	100	

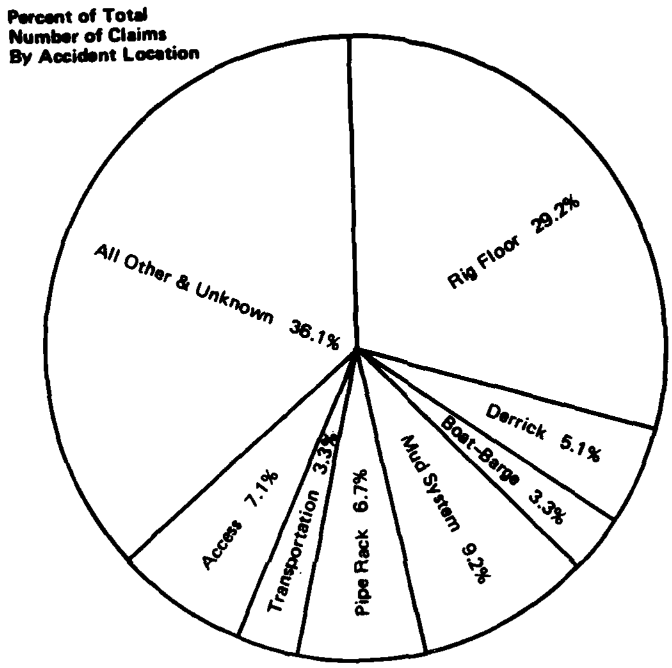
Body Part	IADC Number	IADC Percentage	USCG Number	USCG Percentage	
Eyes	158	3.9	197	10.1	
Arms	297	7.4	145	7.5	
Hands	272	6.8	110	5.7	USCG
Unclassified	60	1.5	82	4.2	65.1
Feet	266	6.6	124	6.4	
Head	301	7.5	177	9.1	
Trunk	1,394	34.7	425	21.8	IADC
Fingers	583	14.5	366	19.9	59.5
Legs	614	15.3	303	15.5	
Toes	76	1.9	25	1.2	
Totals	4,021	100	1,954	100	



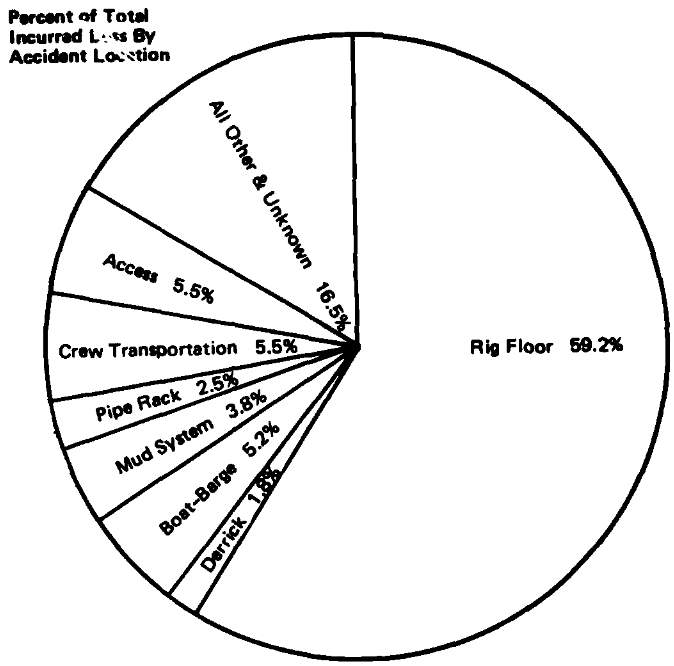
ENCLOSURE (2)
2.1


Percent of Total
Incurred Loss By
Occupation
Other 6.4%
Driller 22.4%
Floorhand 40.6%
Roustabout 20.2%
Crane Operator 4.5%
Derrickhand 5.9%

2.2


Percent of Total
Number of Claims
By Accident Location
Rig Floor 29.2%
Derrick 5.1%
Boat-Barge 3.3%
Mud System 9.2%
Pipe Rack 6.7%
Transportation 3.3%
Access 7.1%
All Other & Unknown 36.1%

2.3


Percent of Total
Incurred L..s By
Accident Lo..tion
All Other & Unknown 16.5%
Access 5.5%
Crew Transportation 5.5%
Pipe Rack 2.5%
Mud System 3.8%
Boat-Barge 5.2%
Derrick 1.8%
Rig Floor 59.2%

2.4

January 1, 1977 - October 1978

Day of Week

Day	No. Acc.	Incurred Loss
Monday	9	$7,275
Tuesday	6	$11,194
Wednesday	4	$6,941
Thursday	10	$65,984
Friday	11	$35,809
Saturday	12	$22,779
Sunday	4	$43,500
Total	56	$193,482

Time of Day

Time	No. Acc.	Incurred Loss
6 AM - 12 Noon	8	68,638
12 Noon - 6 PM	13	45, 352
6-PM - 12 Midnight	16	37,846
12 Midnight - 6 PM	9	16,807
Unknown	10	24,839
Total	56	193,482

Occupation

Occupation	No. Acc.	Incurred Loss
Floorhand	17	100,951
Derrickhand	5	7,174
Crane Op		
Roustabout	21	61,582
Driller	2	2,772
Other	11	21,003
Total	56	193,482

Location on Platform

Location	No. Acc.	Incurred Loss
Rig Floor	19	97,919
Derrick	2	6,550
Boat Barge	3	30,150
Crane	2	869
Mud System	10	26,883
Pipe Rack	6	1,061
Blowout Preventer		
Crew Transportation	1	6,200
Step - Stair	3	974
Walkway - Platform	1	118
Ladder		
Yard		
Other	9	22,758
Total	56	193,482

ENCLOSURE (3)

SURVEY OF LOST TIME OCCUPATIONAL INJURIES OCCURRING ON CONOCO OPERATED PROPERTIES IN OCS WATERS

by
John E. Whitman
Conoco, Inc.

General Facts:

1. This study spans a four-year period--1976 through 1979. During this time, there were 594 lost time occupational injuries reported for contract personnel and 15 reported for Conoco personnel.
2. These data are for contract and company personnel.
3. Contract worker lost time occupational injuries occurred over 7 times more frequently than those of Conoco personnel.
4. Within the contract worker category, drilling was the most dangerous activity. Most of the injured were floormen and pipe handlers involved in tripping pipe.
5. Transportation shows a fairly high frequency rate. The vast majority of these injuries were boat related. The few helicopter injuries experienced were by Conoco workers only.
6. Of the total 609 accidents (company and contract personnel), only 39 or 6 percent were crane-related injuries.
7. Also, 78 percent of all company and contract accidents occurred on the top deck of the rig/platform. The remaining 22 percent occurred on the middle and lower decks or on crew boats and work boats.
8. Please note that very few of the total injuries were disabling. In fact, only 3 of the 609 injuries were fatalities.
9. A large percentage of the injuries were bruises and sprains occurring to the back and leg--this indicates only minor injury. There were also quite a few minor hand and finger injuries.
10. Within the four year period studied, there has been a decrease in the accident frequency for both company and contract workers.

Lost Time Occupational Accident Frequency Rate
For OCS Waters
(Number Accidents/Millions Manhours Exposure)

	1976	1977	1978	1979	Cum.
Contract Workers					
Frequency Rate	61.7	43.7	41.1	37.9	45.1
Transportation	40.3	34.8	35.1	41.3	37.8
Drilling	60.0	56.2	52.4	44.6	52.5
Production	81.8	20.8	17.3	15.1	33.1
Conoco Employees					
Frequency Rate	7.0	8.7	6.8	3.2	6.4
Transportation	17.5	17.3	34.1	0.0	16.9
Production	5.8	7.7	3.8	3.6	5.2

Contract Employee Accidents
OCS Waters

Areas of Activity	1976	1977	1978	1979	Total
Transportation: (Boats)					
Riding in Transit	1	2	1	9	13
Embarking/Disembarking	11	11	7	7	36
Loading/Unloading	6	8	13	8	35
Maintenance	4	4	2	5	15
Total	22	25	23	29	99
Drilling:					
Tripping Pipe	28	40	26	30	124
Working on Valves/BOP's	6	3	--	9	18
Handling Chemicals	3	5	3	3	14
Moving Supplies	7	12	16	12	47
Servicing Equipment	15	12	11	23	61
Painting/Sandblasting	3	2	5	2	12
Welding	2	5	6	--	13
Crane Accidents	2	12	5	6	25
Slip/Fall	24	17	22	20	83
Total	90	108	94	105	397

Contract Employee Accidents
OCS Waters

	1976	1977	1978	1979	Total
Production					
Welding	8	3	1	--	12
Painting/Sandblasting	11	3	--	1	15
Crane Accidents	4	1	1	1	7
Slip/Fall	18	5	2	5	30
Machinery Maintenance	8	1	2	4	15
Moving Supplies	9	3	6	1	19
Total	58	16	12	12	98
Grand Total	170	149	129	146	594

Contract Employee Accidents
OCS Waters

	1976	1977	1978	1979	Total
Injuries					
Type of Injury:					
Amputation	1	3	3	3	10
Break/Fracture	16	13	6	18	53
Bruise	63	55	43	67	228
Burn	13	7	5	2	27
Crush	8	6	11	9	34
Cut	24	13	20	15	72
Eye Irritation	8	8	10	3	29
Sprain/Strain	34	39	29	28	130
Death	1	--	--	1	2
Miscellaneous	2	5	5	--	9
Total	170	149	129	146	594

Contract Employee Accidents
OCS Waters

	1976	1977	1978	1979	Total
Part Injured:					
Abdomen	7	3	6	--	16
Arm	13	15	10	9	47
Back	24	31	22	28	105
Chest, Ribs and Shoulder	9	7	10	16	42
Eye	12	11	14	4	41
Finger	20	14	7	22	63
Foot	13	16	14	9	52
Hand	11	15	10	14	50
Head and Neck	14	6	10	9	39
Leg	46	29	26	34	135
Death	1	--	--	1	2
Miscellaneous	--	2	--	--	2
Total	170	149	129	146	594

Contract Employee Accidents
OCS Waters

	1976	1977	1978	1979	Total
Cause of Injury:					
Caught Between Object	22	28	21	25	96
Chemical Irritation	6	5	5	3	19
Fire	1	1	2	--	4
Foreign Particle in Eye	8	8	11	3	30
Lifting	8	6	7	3	24
Miscellaneous	4	7	0	1	12
Over-Exertion	14	9	5	8	36
Rough Sea	3	1	0	14	18
Slip/Trip/Fall	48	38	36	38	160
Striking Against Object	13	15	6	12	46
Struck by Object	31	26	29	24	110
Struck Self	12	5	7	15	39
Total	170	149	129	146	594

Cause of Injury: (Examples)

Caught Between Objects

Drill Pipe, DC
Elevators
Spinning Chains
Tongs
Etc.

Chemical Irritation

Battery Acid
Calcium Chloride
Caustic Soda
Corrosion Inhibitor
Drilling Mud
Etc.

Fire

Blast Burns
Flash Fires

Foreign Particles in Eye

Metal
Paint
Slag
Rust
Etc.

Lifting

Barrels
Cables
Paint
Pipe
Etc.

Miscellaneous

Black Outs
General Nausea
Heart Prostration
Heart Attack
Sun Stroke
Etc.

Over-Exertion

Pulling Pipe
Pulling Tongs
(Hernias, Pulled Groins, Strain
Stomach Muscles)

Rough Seas

Knocked Out of Boat Seats
Knocked Down by Wave
Walking on Deck
Working on Boat

Slip/Trip/Fall

Ascending/Descending Stairs
Climbing Ladders
Stepped in Holes
Stumbling Over Objects
Transferring to/from Boat
Walking on Deck

Striking Against Object

Hit Legs on Beams
Hit Railings
Stubbed Toes
Transferring to/from boat

Struck by Objects

Boards
Elevators
Ropes
Tongs
Tubing, Pipe, Casing

Struck Self

Hammers
Pipe
Sandblasting Equipment
Wrenches

Conoco Employee Accidents
OCS Waters

Areas of Activity	1976	1977	1978	1979	Total
Transportation: (Boats)					
Riding in Transit	--	--	--	--	--
Embarking/Disembarking	--	--	1	--	1
Loading/Unloading	--	1	--	--	1
Total --		1	1		2
Transportation: (Helicopters)					
Riding in Transit	1	--	--	--	1
Embarking/Disembarking	--	--	1	--	1
Loading/Unloading	--	--	--	--	--
Total	1	--	1	--	2
Production:					
Crane Accidents	--	--	1	--	1
Machinery Maintenance	2	2	--	1	5
Monitoring Production	--	2	--	--	2
Moving Supplies	1	--	--	1	2
Slip/Fall	--	--	1	--	1
Total	3	4	2	2	11
Grand Total	4	5	4	2	15

Conoco Employee Accidents
OCS Waters

Injuries

	1976	1977	1978	1979	Total
Type of Injury:					
Break/Fracture	1	--	1	--	2
Bruise	--	--	--	--	--
Burn	--	1	1	--	2
Crush	--	1	--	--	1
Cut	1	--	--	1	2
Eye Irritation	--	--	--	--	--
Sprain/Strain	2	2	2	1	7
Death	--	1	--	--	1
Total	4	5	4	2	15
Part Injured:					
Arm	--	--	1	--	1
Back	2	--	1	--	3
Eye	1	--	--	--	1
Finger	--	1	--	1	2
Foot	--	--	--	--	--
Hand	--	2	--	--	2
Head	1	--	--	--	1
Leg	--	1	2	1	4
Death	--	1	--	--	1
Total	4	5	4	2	15

Conoco Employee Accidents
OCS Waters

Cause of Injury:

	1976	1977	1978	1979	Total
Cause Between Object	--	1	--	1	2
Chemical Irritation	--	--	--	--	--
Fire	--	2	1	--	3
Over-Exertion	2	--	--	--	2
Slip/Trip/Fall	--	1	1	1	3
Striking Against Object		--	1	--	1
Struck by Object	2		1	--	3
Miscellaneous	--	1	--	--	1
Total	4	5	4	2	15

John E. Whitman is Manager, Offshore Operations, Conoco, Inc.

CRANE SAFETY IN OCS OPERATIONS

by

Lawrence R. Zeitlin

Crane Utilization

Cranes are general purpose pieces of lifting equipment which find broad utilization in all phases of OCS activities. They are characterized by a movable boom which can be angled from near vertical to near horizontal and can rotate on a vertical axis. Cranes can position a load throughout the circle sector delimited by boom length and rotational arc. This load handling flexibility makes cranes useful wherever equipment, supplies, drill rod and casing, construction material or personnel must be moved from vessels to the platform deck and from deck storage areas to working areas.

Crane Equipment on the OCS

Most drilling and production platforms in the OCS are equipped with two or more pedestal mounted cranes capable of working individually or in tandem for heavy loads. Throughout the OCS over a dozen manufacturers are represented but the bulk of the business is concentrated in a small number of companies. Table 1 shows the distribution of crane manufacturers represented in a 20 percent sample of the rigs operating in the OCS. The modal crane lifting capacity in the sample is 30 tons, based on a 50-foot boom, with the load at a 30 ft. radius. Crane sizes run to 75 tons on some of the larger rigs and down to 12.5 tons on older or smaller rigs. Larger capacity ship or barge mounted cranes of up to 3000-ton size are used in platform construction.

Crane Related Accidents

The very nature of crane operation requires that heavy or awkward loads be moved from level to level in close proximity to equipment or personnel. When massive loads are lifted or swung, possibly under conditions of poor visibility or inclement weather, there is always the possibility of personnel injury or equipment damage. Operational errors or structural failure of crane components usually result in dropped or free swinging loads with undesirable consequences.

Crane utilization is highest during the field development and drilling phases of OCS operations. The frequency of lifts, in conjunction with the high crew density at these times, makes the likelihood of personnel injury greater than in other operational phases.

TABLE 1

Cranes in Use in Gulf of Mexico OCS (72 Rig Sample)

Equipment Manufacturer	Type of Rig Submersible	Semi-Submersible	Jack-up
Le Tourneau	4	-	37
Link Belt	6	11	15
Unit-Mariner	17	1	11
American	3	9	5
Manitowoc	1	15	-
Clyde	8	6	-
National	-	5	2
Livingston	2	-	-
Nautilus	2	-	-
Joe Stein	1	-	-
Mobil	1	-	-
Number of Rigs	28	19	30
Average Cranes Per Rig	2	2.5	2.33

Reference: Ocean Industry; 1980 Census of Drilling Rigs

The crane accident data base is relatively unreliable. The various agencies charged with gathering this data use different criteria for inclusion of an incident within the data base. An examination of the available statistics shows that the same accident may have been counted several times in summary reports (i.e., by combining USGS-OCS and USCG statistics or by combining UK Dept. of Energy and Det norske Veritas reports). The only way of avoiding this problem is by considering each data base as an independent entity and operating within its criteria for information gathering; or by becoming so familiar with the record of crane accidents that individual items can be recognized and excluded from double counts. Both strategies were utilized in developing the accident rates cited here.

Table 2 represents the result of a consolidated listing of serious crane related accidents in the OCS from 1971 through 1979. Excluding a helicopter crash in which 17 persons were killed when a blade hit a crane cable, a total of 27 serious incidents involving personnel injury or fatality were reported. The accident rate esti- mates based on the assumptions made in the table show that while cranes are relatively safe pieces of equipment, approximately five fatalities or serious injuries may be expected in the coming year.

Crane related incidents involving fatality, injury, or major equipment damage accounted for 7.3 percent of a sample of serious OCS accidents reported to the USGS from 1971 through 1979. Seven men were killed and six were seriously injured in crane related incidents in this sample.

Between 1965-1975 the UK Dept. of Energy reported 225 accidents of which 38 (17 percent) involved cranes. British experience from 1966 through 1978 shows that crane related accidents were responsible for 3.6 percent (3 out of 84) of all fatalities on the Norwegian Continental Shelf).

Det norske Veritas reported that 10.1 percent of all crane accidents in the North Sea involved personnel injury and about half of these were fatal.

Table 3 provides an analysis of crane related accidents from the OCS events file from 1971 through 1979 listing probable proximate cause, probable improper procedure, and probable operator error.

Structural factors in Crane Safety

The structural design of cranes is a mature art. Cranes have a 2000 year continuous history of use in construction. The basic refinement of design has been the application of ever stronger materials and more reliable power sources to what is essentially a simple machine of levers and pulleys. If operated within design limits, properly maintained cranes rarely fail because of structural reasons. Still, several instances have been reported of crane

TABLE 2

Crane Related Accidents

Rigs in Operation

Year	Rigs	Fatalities	Serious Injuries
1971	193	1	1
1972	139	1	1
1973	137	-	-
1974	149	1	2
1975	188	-	1
1976	212	3	4
1977	259	1	4
1978	284	3	2
1979	321	2	-
	1832 rig years	12	15 = 27

Accident Rate Estimates

300 working days/yr = 549,600 rig days
100 lifts per crane per day (2 cranes/rig) = 109,920,000 Lifts

9,160,000 Lifts/Fatality
4,071,111 Lifts/(Fatality and Serious Injury)

152.67 Rig Years/Fatality
67.85 Rig Years/ (Fatality and Serious Injury)

Based on above accident rate, 5 injuries or deaths expected in 1980. Transportation and helicopter accidents excluded.

Source: Based on Geological Survey data.

TABLE 3

Analysis of Crane Related Accidents 1971-1979

Total Accident Sample = 179
Crane Related Accidents = 13 (7.3%)

Probable Proximate Cause

	Fatality	Serious Injury	Major Damage	Total
Equipment Failure *	3	2	-	5
Improper Procedure	1	3(1)+	1	5
Operator Error	3	-	-	3
Total	7	5	1	13

Probable Improper Procedure

Overload	4	
Failure to Move Clear Visibility	2	
Working on Moving Load		1
Improperly Secured Load		2

Probable Operator Error

Control Error	2
Reckless Operation	1
Signaling Error	1

* May have involved improper procedure
\+ Multiple fatality, injury

Source: Data from Geological Survey Events File and OCS Safety Alerts pedestal or kingpin failure resulting in equipment damage and loss of life. Barring undiagnosed material flaws or improper selection of materials in manufacture, it is likely that such events can be traced to a past history of faulty installation, repeated overload, corrosion, or poor inspection.

The chief engineer of a major crane manufacturer noted that while it is certainly possible for cranes to fail because of a single stress far in excess of design capacity, it is far more likely for the failure to occur as the result of repeated stresses slightly in excess of load limits. Each such stress takes its toll, stretching fasteners slightly beyond elastic limits, breaking a few cable wires, deforming bearings and, in general reducing the margin for overload conservatively incorporated into design. The result is that the crane may suddenly fail when lifting a load that has been handled successfully many times before. The record of stressful operations is incorporated into the metal of the structure and, if appropriate corrective action is not taken, may shorten the crane's safe operating life.

Some design decisions may reduce the crane's tolerance for careless operations. In order to give long reach without prohibitive weight, and at the same time maintain high load capacity, the boom may be of such light skeletonized construction that its resistance to heavy side and twisting strains may be compromised. Sometimes a boom so strained may collapse, but more often will twist slightly, bending some of the cross braces particularly on the lower side. Once twisted, normal loads may increase the damage and failure will follow if the boom is not straightened.

A more frequent equipment-related cause of failure is wire rope breakage. Although this is a structural failure, rope breakage is usually considered a maintenance problem, because most instances are traced to delay in replacing a worn rope or in replacing the original rope with one which does not meet the manufacturer's specifications.

There exists considerable uncertainty in specifying load capacity for the dynamic loads often encountered in a marine environment. The rapid fluctuation in loading as a crane lifts a heavy object from a pitching, heaving deck may momentarily impose stresses in excess of design capacity. A common solution to load specification for cranes used aboard ship is to provide a safety factor by derating capacity from 30 to 50 percent. Such a conservative approach is not generally followed for cranes used on relatively fixed platforms. Operation near load limits in transferring heavy objects from workboats to the deck, particularly when the boom is near the far limits of extension, can accumulate the overload history which leads to early failure. What is not generally recognized is that sudden decreases in loading may be more stressful to the structure than sudden increases in loading. Heave compensation devices may eventually minimize this problem but to date have not been successfully utilized on the OCS.

Control and Visibility Factors in Crane Safety

Cranes have three basic movements, hoisting, booming, and swinging and require an appropriate control device for each. Controls for the major movements plus a number of ancillary controls related to the power system are arranged in the cab in a manner which is a compromise between operator convenience and mechanical expediency. API Spec 2C suggests that the control layout be in accordance with SAE Recommended Practice J983 Crane-shovel Operating Control Arrangements. SAE J983 was formulated when most cranes were operated by direct clutching controls. The specification implies that the operator remains in a fixed position in the cab and that controls should be arranged to permit him to exert considerable mechanical force on the control levers.

Most modern cranes have electric or hydraulic controls which require no direct mechanical linkage to gearing or cable drums, thus freeing the designers of the mechanical restraints imposed by a fixed layout. Control operation and location could therefore be determined by considerations of operability and safety. Unfortunately few crane manufacturers have taken full advantage of the flexibility of modern control systems in optimizing man/machine relationships.

As a case in point, there exists a conflict between control movement/crane movement philosophies between several of the major manufacturers. One of the most respected tenets of human factors is the "principle of the moving part." Simply stated, this concept requires that, to avoid errors, a control should move in the same manner as the desired motion of the device controlled. One manufacturer's electrical control system requires the operator to rotate potentiometers to control swing and hoist motors, clockwise for right swing and hoist, counterclockwise for left swing and lower. The relationship is fine for swing but not quite as good for raising and lowering the load. Another manufacturer's hydraulic control system uses levers moving fore and aft to control swing, booming, and hoist. In one system the brake is automatically applied when hoist motion ceases; in the other, a separate operation is required to engage the brake.

These differences in control philosophy, while insignificant for an experienced operator accustomed to the "personality" of a particular crane become increasingly important for inexperienced operators or for the experienced operator who transfers to a crane of another make. One of the most common error modes in a crisis situation is to respond to an emergency with a previously learned behavior which may be inappropriate in the new conditions. With the number of rigs increasing at a rapid rate, with job tenure decreasing, and with personnel mobility at a high level, there exists the virtual certainty that a crane operator may be exposed to a variety of different crane control systems during a working lifetime. With each change in control system, the probability that inappropriate or erroneous actions may occur in an emergency situation increase.

Further, while experienced operators are permanently assigned to cranes during the drilling phase, during production crane usage is less frequent and personnel are not permanently assigned the position of crane operator. A control arrangement should be devoid of ambiguity if accidents are to be minimized during this condition.

The major man/machine problem during crane operation is impaired visibility. The lift point and the load destination may be out of the operator's direct line of sight.

Poor visibility necessitates the increased use of signalmen or flagmen to guide the operator. Communication problems appear to be frequent contributing factors in crane related accidents. Two-way radio has found increasing use as a supplement to hand signals but it is by no means universally employed.

One incident from the Geological Survey's OCS Events File illustrates the interaction between experience, control, and visibility factors in accident causality. During the production phase of operations (inexperienced operator), the crane operator stepped out of the cab to see more clearly (impaired visibility). He reached back for the pick up line clutch but got the fast line clutch instead (control layout). The fast line weight ball severed from the line and struck the operator, killing him.

There is ample precedent for increasing the safety and efficiency of crane operations by optimizing the man/machine relationships. The British government sponsored a study and consequent redesign of the cab and control system of traveling cranes used in the British Iron and Steel Industry, reporting significant increases in efficiency and reductions in crane related accidents. Similar studies in the U. S. have improved productivity of drag lines used in phosphate mining off the Florida panhandle. Overall crane performance is directly related to operator performance. Optimization of the man/machine interface is a low cost way of upgrading the entire system.

The first objective of such efforts should be the standardization of control motion/machine motion relationships and the arrangement of controls. An equally important task is the improvement of visibility through the relocation of the control station as far forward as possible and/or the provision of alternate or remote control stations for improved visibility in difficult lift situations. Several crane manufacturers currently provide electrical remote control facilities for major crane functions.

Finally, because of the critical relationship between boom angle and load capacity, a foolproof method of displaying safe and dangerous regimes of operations is required. Load moment sensors have been used but are considered unreliable. In this day of $9.98 engineering calculators, direct computation and display of the boom angle/capacity relationship does not seem farfetched.

Maintenance, Test, and Inspection Factors in Crane Safety

Because cranes have a number of components subject to wear, stress, and fatigue, a program of inspection, test and maintenance is required to ensure safe and efficient operation. The USCG requires crane certification based on a review of plans submitted and a continuing program of inspections and tests carried out in accordance with API RP 2D, Recommended Practice for Operation and Maintenance of Offshore Cranes. Cranes are tested in excess of rated load at both maximum and minimum boom angles upon installation, each 48 months, and after repair or alteration of structural components. Each company establishes its own routine of testing and preventive and scheduled maintenance generally in compliance with the recommendations of API RP 2D.

The inspection and maintenance items most critical to crane safety are those involving structural and load handling components directly stressed during lifting operations. These include pedestal bearings, boom, load blocks and cable, brakes and clutches, and safety devices such as limit switches. Careful inspection is required to identify and arrest the gradual deterioration of structural integrity caused by repeated stresses near the load capacity limit.

The OCS events file identifies several structural failures which may be attributed to lapses in the inspection/maintenance process. Among these are failure of pedestal bearings, kingpin failure, brake slippage, and broken ropes.

The most common maintenance-related failure appears to be caused by delay in the replacement of wire rope after evidence of wear appears. Wire rope has a definite life span and is intolerant of overload. Breakage of several wires in a strand transfers increasing load to the remaining wires and failure progresses rapidly. Improper or neglected lubrication accelerates the process.

Operator Factors in Crane Safety

Perhaps more than any other piece of equipment on a rig, crane productivity and safety is determined by operator skill. The crane operator is required to exercise considerable judgment and responsibility, assessing the dynamic factors involved in moving heavy or irregular loads, often to or from a heaving workboat deck. He customarily works with crewmen or signalmen who will be endangered by his mistakes. The deck area of most drill rigs is crowded and there is a high probability of causing extensive damage if a load is mishandled. The items lifted may be both fragile and expensive.

The high emphasis on operator skill has several implications. First there is a considerable requirement for operator skills training. API RP 2D sets the broad requirements for operator qualifications, but in fact leaves it up to the operating companies to specify the training necessary to "be fully qualified through training and experience." A qualified person is merely defined as:

> "A person designated by the employer who by reason of experience or instruction is familiar with the operation to be performed and the hazards involved."

Several companies have elaborate training programs for crane operators involving both classroom and on-the-job training, with periodic retraining and reassessment of operator skills. Other companies recruit onshore union-trained construction crane operators, providing supplementary training for offshore operations. Still others have no formal training program at all and rely on recruitment of crane operators from other drilling companies. It is apparent that formal skills standards vary among operating companies.

Independent of training, there is no substitute for "feel" in crane operations. A good crane operator has a high degree of hand/eye coordination and the instinctive judgment of spatial relationships that is characteristic of the natural athlete. If an operator is good, he knows it and he is eager to demonstrate his skill at every opportunity. The crane operator is on center stage. His successes and failures cannot be hidden. Obviously skilled performance always provides status amongst one's peers and most crane operators are confirmed status seekers and exhibitionists. This tendency counter acts the natural conservatism that would be desirable for safe operations. Most crane operators feel the crane to be an extension of themselves. They push the limits of prudence because they really feel that there is no job that they cannot handle.

This characteristic is not restricted to crane operators but is found in most persons who seek positions in which they will be the center of attention as they demonstrate their skills. Truck drivers, small boat handlers, pilots, high steel workers, etc. are all cut from the same cloth. The successful, as opposed to merely skilled, crane operator is the one who learns to temper his exhibitionistic tendencies with an appreciation of the risks involved. This appreciation comes with experience but can be hastened by a management policy and a training program which emphasizes safety.

API RP 2D spells out in fair detail operating practices which should be followed to ensure safety. It is apparent from both the USGS Events File and the USCG Accident Reports that many of the recommendations involving load handling and load motion are being overlooked. Most accidents are caused by falling or swinging loads. Slings or other fastenings break or slip off and the crane operator should be fussy about both their strength and their manner of fastening. When a load is swung, it is difficult for either the operator or his crew to judge exactly the path that will be taken, particularly if the object is irregular in shape. Its distance in or out can be affected by centrifugal force, by strong winds or wave motion, or by the settling of a boom against a defective brake. Therefore constant care is needed to make sure that the load does not hit personnel or knock objects over on them. A recommendation honored in the breach is the prohibition of carrying a load over personnel or permitting them to work on a load while it is being lifted. Most of the fatalities related to crane accidents in the OCS file result from objects falling from loads onto persons below or workers being crushed by unpredictable movements of a load on which they are working.

Major Areas of Concern

In the course of developing this material a number of areas of concern became apparent. Some were expressed by knowledgeable personnel, some appeared in the literature, and some just seemed obvious. If carefully investigated, all should offer some promise of increasing safety of crane operations. They are:

1. Operator-signalman communications.
2. Crane overload practices which precipitate equipment failures.
3. Lifting or swinging loads over personnel.
4. Visibility problems.
5. Control standardization to minimize control errors.
6. Heave compensation to reduce dynamic overloads.
7. Maintenance of equipment.
8. Sling or cargo net failure.
9. Crane operator training and selection standards.

Two specific recommendations for improving crane safety and the efficiency of crane operations are:

- Review of American Petroleum Institute Recommended Practice 2C in the area of crane control layout and cab design to incorporate recent advances in human factors knowledge and control and display mechanization. Fairly precise information is now available about control/display relationships that increase efficiency, decrease training time, and minimize the chance of operator error.

- Develop industry-wide standards of certifying operator skill to insure at least a basic level of proficiency. Regardless of source of training, a crane operator should be required to demonstrate skills and knowledge of regulations prior to being issued a "driver's license" by an industry-accepted agency.

Lawrence R. Zeitlin is Professor of Industrial Psychology and Organizational Behavior at Baruch College of the City University of New York, where he directs the graduate program in human factors. Dr. Zeitlin is a member of the Committee on Assessment of Safety of OCS Activities.

DEVELOPMENT OF FIXED-LEG PLATFORM TECHNOLOGY

by

Griff C. Lee

Design. The general requirements of an offshore platform are similar to any other industrial structure in that it must fulfill its intended purpose. It must be structurally adequate for both operational and environmental loading, and must be practical to construct. It also must be economically feasible. As part of an overall system, the platform must be cost effective and provide a satisfactory return on investment. The design of an offshore platform does not reflect aesthetic or architectural considerations; the concept is based almost totally on the method of installation. In other words, the structural configuration, layout, and design for normal operational and environmental loadings are built around the installation procedures.

At the outset of the design of an offshore platform, it is necessary to determine the foundation conditions at the site and to predict the environmental loading conditions--wind, wave, current, ice, earthquake, etc., which the structure must resist. It is usually not practical to design for the absolute maximum environmental occurrence, but rather for some less severe conditions more likely to occur during the life of the structure. It is normal practice to use the recurrence interval as a means of identifying the selected design criteria. The structure is then designed for particular conditions likely to be equaled or exceeded in the selected time period. For instance, the 100-year storm is not the storm predicted to occur once each century in the entire area. It is a storm which is projected to have a one-percent chance each year of occurring and passing close enough to the location to subject the platform to forces equal to or exceeding the design criteria. While costs play a significant role in establishing design criteria, it is also necessary to consider the safety of personnel and the possibility of pollution, as well as the platform's intended use and planned life.

When the first offshore platforms were designed, there was precious little information available concerning environmental conditions or construction operations in the open, exposed ocean. By assembling and applying technology that was available, the industry began offshore operations. Engineering development and research programs were initiated to improve these operations, to extend capabilities into deeper water and more severe environments, and to develop the environmental information necessary for the establishment of environmental design criteria. This process has been in effect for more than 30 years and is still continuing. The fact that our

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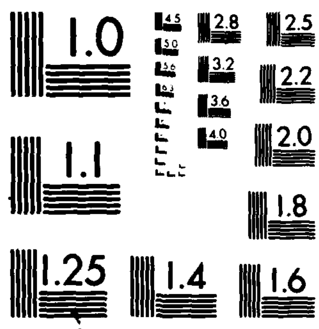
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knowledge of environmental and operating conditions is incomplete means that some risk in engineering design will be present. This situation is not unique to the offshore industry.

Similar to other engineering design undertakings, numerous standards provide a framework for offshore engineering design. The process of researching the standards applicable to a design effort is called establishing the design basis.

After establishing the environmental design criteria and the design basis, the next step in designing an offshore platform is to develop the concept of the structure based on the method of installation. Following this, the layout is selected which will satisfy the operational requirements. A preliminary design for the operational and environmental loading can then be made. The design for operational loads on offshore fixed structures presents no new problems since the same procedures can be followed that are used elsewhere. The design for environmental loading is considered somewhat more unusual due to the complexity of analysis and the magnitude of the loadings. After completing the preliminary structural design, it is then necessary to review the construction procedures, taking into account the stresses which will be encountered for lifting, launching, floating, etc. This will likely change the preliminary concept so that several iterations may be necessary.

The design of platforms for "deep" water is not unrelated to that for shallow water. The same problems are encountered, such as determination of environmental loading, design of foundations and tubular joints. However, these problems may be somewhat more severe due to the increased loading. Deep water platform designs, however, are dominated by factors that are of less importance in shallow water structures. The deep water platform is more slender and, therefore, more susceptible to stress amplification due to wave dynamics which can be safely ignored in shallow water. This also increases the significance of fatigue assessment.

Another difference between deep water and shallow water platforms is the complexity of installation. Due to the weight involved, the capacity of even the newest and largest derrick barges tend to be inadequate for installation concepts depending entirely on lifting. As a result, installation planning becomes more critical and practical application of innovative concepts become a necessity.

Fabrication. Fabrication makes use of a shop environment to preassemble components in order to simplify and speed up field erection. It is the usual practice to fabricate (assemble) an offshore structure into large units on land in a fabrication yard, then transport the units to location so that offshore installation may take place in a minimum time.

The typical steel offshore structure consists of three main components--jacket, deck, and piling. The jacket, or lower unit, rests on the ocean floor and has open pipe columns, or legs, which extend above the water surface. Tubular bracing members interconnect these legs to make the jacket a single rigid structural unit or space frame. Pilings are driven through the legs of the jacket into the ocean floor. The jacket serves as a driving guide during pile installation and as a structural unit to resist horizontal loads from wind, waves, and currents. For deep water, or for soft foundation conditions, it is necessary to splice the piling by welding to reach the required penetration. For shallow water, the jacket is completely fabricated in one piece, carried to location on a cargo barge, picked up and set on bottom by a floating crane or "derrick barge" and the piling then driven. In deeper water, the jacket is usually fabricated on its side, carried to location on a special launching barge and "launched" into the water at location where it floats in a horizontal attitude. It is then rotated into the vertical position and lowered on bottom by the derrick barge or by controlled flooding. The superstructure, consisting of several units or "deck sections," is also assembled in the fabrication yard, carried to location, lifted into position by the derrick barge and the piling installed. This method of construction has been developed to best utilize the capabilities of offshore construction equipment and to minimize erection time at the location.

The conceptual design of fixed-leg offshore platforms has changed little as water depths have increased. Deep water structures are assembled into jackets, piles, and deck sections (or deck frames and modules). Deck sections and modules are installed by lifting. The weight of these sections must be limited to derrick barge capacity. This is not the case for the jackets, however. Since jackets may be installed by launching or flotation, weights of 15,000 to 20,000 tons are not unheard of. Special plans must be made by the fabricator to insure that he will be able to transport a jacket to the open ocean once it has been assembled.

In addition to the weight, the size of the components adds difficulties. Working height in the fabrication yard is of prime concern. As deep water jackets are fabricated on their side, base width controls fabrication working height. The base width, in turn, is a function of a water depth and the slope of the legs of the jacket (the greater the slope, the stiffer the structure). Most large fabrication yards specializing in offshore structures have the ability (or technology) to make heavy lifts or jacket components up to about 300 feet in height. A platform base of this dimension has been found to provide acceptable dynamic behavior and pile loads for water depths in the range of 1,000 feet in the Gulf of Mexico. Beyond this depth, some portions of the jacket have to be fabricated using unconventional means. This increases fabrication time and cost, but is within the current state-of-the-art. Very large jackets which cannot be launched as a single unit must be fabricated into two or more segments. For these units to be connected at sea, very close dimensional tolerances are necessary.

Installation. The most frequent jacket installation technique is launching from a barge at the location. The launch barge must be of sufficient size for marine stability and of adequate strength to support the weight of the jacket, especially as it is tipping (being slid off the barge). Existing launch barges can handle one-piece jackets of over 500 feet water depth, even under harsh environmental conditions, such as those encountered in the North Sea or the Gulf of Alaska.

After the jackets are launched, they must be up-ended (rotated) from the horizontal to a vertical attitude. With shallow water jackets, this traditionally has been accomplished by lifting. Because of the large mass of deep water jackets, this procedure prove to be unsafe even if sufficient lifting capacity were available. This is due to the difference in hydrodynamic response between the derrick barge floating on the surface and the jacket floating almost totally submerged. Surface waves (which cause the barge to move) have little effect on the jacket, and thus cause large dynamic loads on the lifting lines and derrick. Therefore, large deep water jackets must be rotated and set on bottom entirely by controlled flooding. This requires sophisticated flooding and venting systems, with appropriate backups, which must be carefully designed and fabricated. Model tests and detailed operational instructions, including contingency plans, are essential to succesful up-ending by flooding.

Jackets which are to be rotated by controlled flooding require reserve buoyancy. The jacket must be stable while floating on the surface and during rotation to the vertical. As the lower end is flooded, the buoyancy is reduced. Therefore, sufficient buoyancy is needed not only for stability during rotation, but also to maintain proper mudline clearance after vertical attitude is attained. Supplemental buoyancy has been required for most deep water North Sea jackets due to their very heavy weight. One method of providing this buoyancy has been to use long cylindrical tanks inserted in the pile guides in the upper end of the jacket. These tanks are removed after the jacket is in place.

After the jacket has been set on the ocean bottom, it is leveled and pilings are stabbed through the jacket legs. When the pilings have been driven to the proper penetration, the deck unit, or units, are lifted into place and set on the top of the piling. The connections between the deck leg and the piling, as well as the piling and jacket, can then be made and all other items can be performed necessary to complete the structure. During this "weld out" process, the drilling rig and/or any other package or modules are set on the structure.

When deep water jackets are too heavy for available launching equipment, the concept of a self-floating jacket is a viable alternative. Self-floating jackets have been used about two dozen times compared to hundreds of jacket launchings. The self-flotation structure is characterized by legs which have a sufficiently large diameter that buoyancy is provided. This enables the jacket to float at a relatively shallow draft. Because this buoyancy is built into the jacket (rather than into the launch barge), more steel is usually required. In addition, the extra wave and current forces on the larger legs requires increased structural strength and metal fatigue resistance, resulting in heavier framing and possibly more piling. Fabrication of the more detailed legs is more complex and, therefore, more expensive. These factors, plus the additional control system necessary for up-ending and sinking, have tended to make self-flotation structures more expensive than launched structures. In most instances, other considerations, such as launching equipment not being available, or utilizing large legs to protect wells from ice forces, have justified the decision toward a self-floating platform. It is questionable whether a self-flotation jacket has ever been selected purely on the basis of economics of the structure alone.

Jackets have been installed in approximately 700 feet by launching, and 500 feet by self-flotation. As the water depth increases, the jackets finally become too long and too heavy to be handled in one piece in a conventional manner. The sectionalized jacket concept has been developed to cope with this situation. The jacket is fabricated in one piece, then separated into sections after fabrication is completed. Each of these sections is launched separately and reconnected while floating in a horizontal attitude. This connection is made by a system of locking hydraulic flanges and subsequently reinforced by full-strength welds made from inside of the legs. This procedure was used with complete success for the "HONDO" platform in 850 feet of water in the Santa Barbara Channel. This technique could be extended to deeper water by connecting three or more sections in a similar manner.

As an alternative, a similar multiple-section launched jacket concept may be utilized by first up-ending the sections, and then "stacking" and connecting the sections in their up-ended or vertical attitude at the installation site. In this case, however, the base section must be lowered to the bottom, leveled, the skirt piles stabbed, driven with underwater pile hammers and grouted to the base section prior to "stacking" the upper sections on top. This procedure was used in the Mississippi canyon area in the Gulf of Mexico for the "COGNAC" platform standing in 1,025 feet of water.

The knowledge gained in recent years by the offshore industry from various engineering studies and from design and construction of deep water structures, such as "HONDO" and "COGNAC," indicated that it would be feasible to install a jacket for 1,000 feet of water in one piece. The major constraint has been transportation from the fabrication yard to the installation site. This problem has now been eliminated with the construction of a "super" launch barge 650' x 170' x 40', with a design launch capacity of 42,000 tons. The first one-piece deep water launch using this barge will be the CERVEZA platform in the Gulf of Mexico. Construction of the platform began in the spring of 1979. The jacket configuration is similar to a traditional Gulf of Mexico 8-pile structure, but on a larger scale. Even with the larger size launch barge, the jacket will still overhand the barge by almost 300 feet. Installation is scheduled for the summer of 1981. The single-piece jacket will allow the standard installation techniques that have evolved over a period of many years to be used instead of the time-consuming, high-technology operations required for sectionalized jackets. This should result in a substantially less expensive structure.

Maintenance, Inspection, and Repair. As an industrial structure, an offshore platform serves as a foundation for operations which require a rugged support system. As an ocean structure, it is subjected to the continued wind and wave loadings associated with the marine environment. Maintenance and repair of offshore structures is expensive, particularly for the submerged portions of the platforms.

It is general practice to design offshore platforms to be as maintenance-free as possible and to prevent structural degradation and damage over the platform life. Except for the corrosion protection system, the basic structure is designed to require no maintenance from normally anticipated events which fall within the design criteria. It is intended that the basic structure would need inspection, repair, or maintenance only when it has been subjected to unplanned severe loadings, such as collision or an unusually severe environmental event which exceeded the design criteria. The platform protection system (barge bumpers, boat landings, riser protectors, etc.) are designed to protect the structure from normal operational impacts. These systems are also designed to be replaced when damaged by above-normal operating loads. The cathodic protection system is designed for a very long life and is replaced or supplemented as its ability to protect the structure decreases below minimum levels.

For maintenance and inspection purposes, a platform is divided into three areas: the above-water portion, or super-structure; the splash zone; and the below-water or submerged portion of the platform. The above-water portion or deck units are protected from corrosion by a sophisticated painting system for use in the exposed marine atmosphere. This part of the structure is above water and available for inspection and maintenance painting similar to other industrial structures exposed to corrosive environments. The below-water portion of the structure is protected by cathodic protection designed to give adequate coverage to all of the surface areas. As a general rule, aluminum or other sacrificial anodes attached to the structure are used to supply the electrical potential required to prevent corrosion. With the size and spacing of these anodes, protection life of up to 20 years is planned. The use of anodes has proven to be more simple, rugged, and generally more satifactory than impressed current systems. The splash zone is an area at the water level that is alternatively wet and dry to normal wave action. Since it is in air part of the time, cathodic protection is not effective. Also, painting systems have a very short life since this area is continuously wet and very difficult to maintain. The splash zone is generally protected by either an inert metal sheathing, such as monel, or by increasing the steel wall thickness to allow for sufficient extra thickness to last the useful life of the structure.

Current regulations do not set forth a specific inspection program for fixed offshore structures. Since it is in the owner's best interest to adequately maintain his high investment, offshore operators have developed their own inspection systems. Some are more rigorous than others. In addition, the American Petroleum Institute has established a standard regarding periodic surveys during the life of the structure.[1] The question of "How much is enough?" is apropos regarding inspections.

The folowing schedule of inspections has been recommended by the Marine Board to the U.S. Geological Survey.[2]. The first level is visual inspection of the splash zone and the above-water portions of the platform. This should be made on a periodic basis, or after a potentially damaging event has occurred. If this inspection indicates that there are potential problems below water, then a second-level inspection should be undertaken. This would be a thorough overall inspection including visual inspection under water by divers or by remote means. Second-level inspections are called for when first-level inspections indicate special problems, or after a severe environmental loading or accident has occurred that might possibly have damaged the underwater portion of the structure. If the second-level inspection indicates possible underwater damage, then a more detailed (level-three) inspection is necessary. This should consist of mechanical cleaning and suitable non-destructive testing to determine if actual cracking, etc., has taken place.

While minor repairs are accomplished quite expeditiously, major repairs involve detailed installation planning and require considerable economic study to compare the cost of repair versus the cost of replacement.

Offshore construction and repair is usually planned to avoid work requiring divers or underwater vehicles insofar as possible. Unfortunately, the ability to repair any part of a platform depends on the ability to get men to the problem area as well as on their ability to perform work at the location. A common underwater repair technique is to remove the damaged member and replace it utilizing bolt-on clamps and, in some cases, underwater welding.

Griff C. Lee is Vice President for Research and Development of McDermott, Inc., New Orleans, Louisiana, and is a member of the Marine Board.

NOTES

1. API RP 2A, "Recommended Practice for Planning, Designing, and Constructing Fixed Offshore Platforms," American Petroleum Institute, Eleventh Edition, January 1980.
2. "Inspection of Offshore Oil and Gas Platforms and Risers," National Academy of Sciences, Washington, D.C., 1979.

HURRICANE LOSSES
by
Griff C. Lee

A summary of hurricane losses caused by Gulf of Mexico hurricanes is shown in Attachment A. Also losses due to collisions which occur during hurricanes is shown. Hurricane losses began almost with the initiation of platform construction in the Gulf of Mexico. In 1948, before mobile drilling rigs became available, two small temporary platforms were constructed for shallow-hole testing. These platforms consisted of salvaged bridge trusses supported by unbraced piling. The deck was close to the water surface--just high enough to be cut out of reach of normal wave action. These structures were not intended to be sufficiently strong to resist a hurricane. A hurricane occurred before they were removed. One platform collapsed, the other moved horizontally several feet with an "S" shaped bend in the piling between the deck and the mudline.

In 1949, a hurricane caused severe damage to an offshore platform erected off Freeport, Texas. This damage was largely to the deck section and equipment on the deck. Damage was caused by wave action reaching the deck, which was set at only 20 feet to 30 feet elevation. At the time this platform was designed, one of the leading experts predicted that a 32-foot wave was the maximum which would be encountered in the Gulf of Mexico.

In 1957 Hurricane Audrey came through the Gulf of Mexico, going onshore in the Cameron, Louisiana, area. This hurricane caused the greatest loss of lives to the U.S. However, it traveled through an area with a relatively scattered platform population, causing only minor damage. Two platforms built in the late '40's and early '50's were severely damaged. These platforms did not have an adequate connection between the piling and the jacket; therefore, the structure had very limited resistance to horizontal loading.

In 1961, Hurricane Carla traveled through the central Gulf of Mexico, going onshore in the Texas area. The storm stayed far enough offshore in the Louisiana area that damage to platforms was minimal. Part of a large platform was damaged and three smaller structures leaned over--one from a pile pull-out problem.

In 1964, with this background, Hurricane Hilda came through the Gulf and went onshore in the central Louisiana area, traveling through an area densely populated with platforms. The results were significant. Thirteen platforms collapsed; two others were damaged so severely that removal was required. In addition, five others required major repairs. With one exception, all of the lost platforms had been designed for a 25-year storm. Evidence from upper level damage on platforms which remained standing and wave hindcasting analysis indicated that the wave which occurred had been considerably more severe than the 25-year storm. In other words, the wave criteria had been exceeded. It is believed that all but one of the structures were overloaded by wave action on the deck sections. One section had a cellar deck at an elevation of 51 feet, probably above the wave crest. Unfortunately, it was an old platform which had been salvaged, extended and reinstalled, and appears to have failed due to general overloading. Only one structure, a small well protector, had been designed for a 100-year storm. This structure had been designed before adequate joint analysis procedures were available. The wall thickness at the joint was only 3/8 of an inch thick, well below current standards.

The following year, in 1965, Hurricane Betsy traveled through Louisiana's offshore areas, going onshore just east of New Orleans, again causing extensive damage to offshore structures. Eight structures were totally destroyed. The analysis of the damage was almost identical to that of Hurricane Hilda. Again, with one exception, all of the platforms had been designed for a 25-year storm.

Four years later, Hurricane Camille, traveling just east of the offshore platform area caused extensive damage to Gulfport and the Mississippi Coast area. This storm was probably the most severe to have affected the onshore industry. Waves of 75 feet high were recorded on a platform near the mouth of the river before the wave measurement system became ineffective. This storm caused the loss of two platforms and severely damaged a third so that salvage was required. Unlike previous failures, these losses were not caused by wind and wave action, but by movement (mud slide) of the upper level of supporting soils. In the very soft areas near the mouth of the Mississippi River, it was known that surface movement of soil was possible. However, it was not anticipated that the slide would be caused by a wave action or that it would be as deep or as severe as did occur.

Biographical information on Mr. Lee appears on page 199.

ATTACHMENT A

Hurricane Losses and Severe Damage To Fixed Platforms in Northern Gulf of Mexico

Location and Owner	Water Depth	N. Miles Offshore	Type Platform	NBR Legs	Damage	Criteria	Remarks
1948 Hurricane							
Grande Isle Humble Oil	50'		Tender Type		Lost	None	Collapse - Temporary Platform with Unbraced Piles.
Grande Isle Humble Oil	50'		Tender Type		Severe Damage	None	Temporary Platform with Unbraced Piles "S" Curve in Piles.
1949 Hurricane							
Freeport, TX Ohio-Melbon	50'		Self-Contained		Severe Damage	None	Damage Primarily in Deck and to Equipment.
1957 - Hurricane "Audrey"							
W. Cameron 101 Superior Oil	40'	15	Self-Contained		Severe Damage		Structure Leaning Pile Jacket "Pin" Connection Failure.
Unknown Superior Oil	30'		Self-Contained		Severe Damage		2 Jackets Leaning - Pile to Jacket "Pin" Connection Failure.
1961 - Hurricane "Carla"							
Unknown Superior Oil	40'		Self-Contained		Severe Damage		1 Jacket Leaning - Pile to Jacket "Pin" Connection Failure.
Unknown Zapata Oil	60'		Well Protector	4	Severe Damage		Structure Leaning.
Eugene Is. 198 Placid Oil	102'	45	Caisson Brace	2	Severe Damage		Connection from Brace Caisson Failure.
E. Cameron Shell Oil			Well Protector	4	Severe Damage		Structure Leaning - Pile "Pull Out."

Hurricane Losses and Severe Damage To Fixed Platforms in Northern Gulf of Mexico

Location and Owner	Water Depth	N. Miles Offshore	Type Platform	NBR Legs	Damage	Storm Criteria	Remarks
1964 - Hurricane "Hilda"							
Eugene Is. 276 Union Oil	172'	50	Self-Contained	8	Lost	25-Year	Collapse - Jacket Failure Cellar Deck +31.
Ship Shoal 253 Pure Oil	172'	45	Self-Contained	8	Lost	25-Year	Collapse - Jacket Failure Cellar Deck +34.
Ship Shoal 199-A Tenneco	101'	40	Tender Type	8	Lost	25-Year	Collapse - Jacket Failure Cellar Deck +36.
Ship Shoal 198-B Tenneco	101'	40	Tender Type	8	Lost	25-Year	Collapse - Jacket Failure Cellar Deck +39.
Ship Shoal 198-C Tenneco	96'	40	Tender Type	8	Lost	25-Year	Collapse - Jacket Failure, Cellar Deck +36.
Eugene Is. 208-A CATC	100'	40	Tender Type	8	25-Year		Collapse - Jacket Failure Previously Damaged by Collision.
Eugene Is. 208-C CATC	100'	40	Tender Type	8	Lost	25-Year	Collapse - Jacket Failure Cellar Deck +42.
Eugene Is. 208-D CATC	100'	40	Tender Type	8	Lost	25-Year	Collapse - Jacket Failure Cellar Deck +42.
Eugene Is. 175-A Sinclair	87'	45	Self-Contained	16	Lost	25-Year	Collapse - Old Structure Reused. Cellar Deck +51.
Ship Shoal 154-B Gulf Oil	60'	30	Tender Type	6	Lost	25-Year	Collapse - Jacket Failure Cellar Deck +39.

Hurricane Losses and Severe Damage To Fixed Platform in Northern Gulf of Mexico

Location and Owner	Water Depth	N. Miles Offshore	Type Platform	NBR Legs	Damage	Storm Criteria	Remarks
1964 - Hurricane "Hilda" - Cont'd							
Ship Shoal 154-H Gulf Oil	60'	30	Tender Type	6	Lost	25-Year	Collapse - Jacket Failure Cellar Deck +39.
Eugene Is. 188 Shell Oil	60'	35	Well Protector	4	Lost	100-Year	Collapse - Joint Failure in Jacket Legs - 3/8" Thick Main Deck +20.
Ship Shoal 149-B Signal	50'	35	Tender Type	8	Lost	25-Year	Collapse - Jacket Failure Cellar Deck +38.
Eugene Is. 202 Placid Oil	113'	45	Caisson Brace	2	Severe Damage	25-Year	Jacket Leaning, Deck Lost Indication of Pile Failure Cellar Deck +25.
Ship Shoal 169 Gulf Oil	60'	25	Well Protector	4	Severe Damage	25-Year	Platform Leaning 45°, Deck Lost Well Deck +39.
1965 - Hurricane "Betsy"							
W. Delta 117-B Gulf Oil	214'	35	Tender Type	8	Lost	25-Year	
W. Delta 117-A Gulf Oil	202'	35	Tender Type	8	Lost	25-Year	
W. Delta 118 Pure Oil	192'	30	Tender Type	4	Lost	25-Year	Cellar Deck +42.
W. Delta 97 Forrest Oil	167'	30	Tender Type	4	Lost	25-Year	Cellar Deck +34.
W. Delta 69 #1 CATC	120'	25	Well Protector	3	Lost	25-Year	

Hurricane Losses and Severe Damage To Fixed Platforms in Northern Gulf of Mexico

Location and Owner	Water Depth	N. Miles Offshore	Type Platform	NBR Legs	Damage	Storm Criteria	Remarks
1965 - Hurricane "Betsy" Cont'd							
W. Delta 70 #3 CATC	120'	25	Well Protector	3	Lost	25-Year	Main Deck +36.
Main Pass 129 Phillips Pet.	92'	25	Well Protector	4	Lost	25-Year	
S. Pass 24 Shell Oil	60'	5	Well Protector	4	Lost	100-Year	
1969 - Hurricane "Camille"							
S. Pass 70-B Shell Oil	327'	10	Self-Contained	8	Loss	100-Year	Mud Slide - Collapse (See 1973 OTC Paper #1898).
S. Pass 61 Gulf Oil	280'	10	Self-Contained	8	Lost	100-Year	Mud Slide - Collapse.
S. Pass 70-A Plat- Shell Oil "S"	310'	10	Self-Contained	8	Severe Damage	100-Year	Mud Slide - form Moved - Curve in Piles Below Mudline.

Hurricane Losses and Severe Damage To Fixed Platforms in Northern Gulf of Mexico

Location and Owner	Water Depth	N. Miles Offshore	Type Platform	NBR Legs	Damage	Storm Criteria	Remarks
1974 (Carmen)							
Ship Shoal 119, An Old Platform Platform F ODECO	51	20	Central Production Facility (No Wells)		36 Piles	Platform Toppled as the Result of Collision by Barge During Storm	Unknown
1979 (August)							
South Pelto 19, Satellite Platform #4 ODECO	30	10	Single Well Jacket	3	Toppled During Storm		Unknown
South Pelto 19 Satellite Platform #11 ODECO	30	10	Single Well Jacket	3	Toppled During Storm		Unknown
South Pelto 19, Satellite Platform #13 ODECO	26	10	Single Well Jacket	3	Toppled During Storm		Unknown

Source: Unpublished Studies and Reports by Griff C. Lee, McDermott, Incorporated.

ATTACHMENT B

Collision Damage During Hurricanes To Fixed Platforms in Northern Gulf of Mexico

Location and Owner	Water Depth	N. Miles Offshore	Type Platform	NBR Legs	Damage	Storm Criteria	Remarks
1964 - Hurricane "Hilda"							
S. Timbalier 21 Gulf Oil	35'	5	Well Protector	4	Severe Damage	25-Year	Platform Leaning 45° Indication of Collision with V ssel.
Ship Shoal 32 Keer-McGee	18'	10	Well Protector	4	Severe Damage	25-Year	Platform Leaning 45° Indication of Collision with Vessel.
1965 - Hurricane "Betsy"							
W. Delta 133 Shell Oil	280'	30	Self-Contained	8	Severe Damage		Collision - Part of Mobile Drilling Platform Being Salvaged.

Source: Unpublished Studies and Reports by Griff C. Lee, McDermott, Incorporated.

ATTACHMENT C

Offshore Platform Hurricane Loss
By Year of Occurrence

Northern Gulf Of Mexico

Year	Collapse	Damaged & Removed	Total Losses	Losses To Date
1948	1	1	2	2
1949	-	1	1	3
1957	-	2	2	5
1961	-	4	4	9
1964	13	2	15	24
1965	8	-	8	32
1969	2	1	3	35
1974	1	-	1	36
1979	3	-	3	39
Total	28	11	39	185

APPENDIX

Contributions to the Work of the Committee on Assessment of OCS Activities*

<u>Group 1 - Technology</u>

Purser, P., Incident Data on OCS Safety (Purser data), September 1980

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* Single copies available on request from the Marine Board, National Research Council, 2101 Constitution Avenue, N.W., Washington, D.C., 20418.

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Whitman, John, "Survey of Lost-Time Occupational Injuries Occurring on Conoco Operated Properties in OCS Waters," February 1980

Group 2 - Regulations

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Barnes, W., "Considerations in Deciding Whether New or Improved Regulations are Needed," January 25, 1980

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Perspective (Working Paper 4), June 1980

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Sizer, P., "The Interplay Between Technology and Regulations"

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Zeitlin, L., "Human Factors Aspects of Safety"

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Napadensky, H., "The Potential Contribution of Risk Assessment to OCS Safety Regulation"

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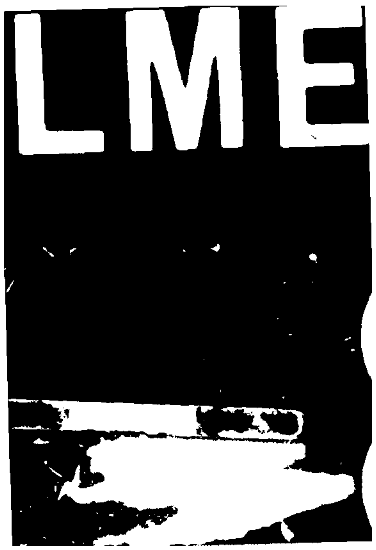
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