WASHINGTON STATE

INFORMATION PRIORITIES

Final Report of the Advisory Committee

Ocean Resources Assessment Program

ON SHORE/OFFSHORE

WASHINGTON SEA GRANT

INFORMATION PRIORITIES

WASHINGTON STATE & OFFSHORE OIL AND GAS

INFORMATION PRIORITIES
Final Report
of the Advisory Committee
Ocean Resources Assessment Program

Washington Sea Grant Program
University of Washington • Seattle 98195

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About the Ocean Resources Assessment Program

In April 1992, the Minerals Management Service (MMS) of the U.S. Department of the Interior (DOI) plans to conduct Lease Sale 132 for offshore oil and gas exploration and development in federal waters on the outer continental shelf off the coasts of Washington and Oregon. This agenda has been the driving force behind recent Washington state actions on this issue. (Earlier, the State Department of Natural Resources had imposed a moratorium on leasing for oil and gas inside state waters.)

The Governor of Washington has asked MMS to delete about half of the lease sale area off the Washington coast and has joined Oregon, California, Massachusetts, and the National Resources Defense Council, an environmental group, in lawsuits against DOI, challenging its current Five-Year OCS Oil and Gas Leasing Program. Meanwhile, MMS is sponsoring several pre-lease environmental studies, and, at this writing, the first step in the sale process is less than one year away. In November 1989, MMS plans to request that oil and gas industry members indicate their level of interest in Lease Sale #132. Under the present plan, if industry interest is sufficiently high, successive steps in the lease sale process will proceed.

Through the Western Legislative Conference in 1986, members of the Washington Legislature became concerned that the state was unprepared for the potential development being planned by the federal government. Engrossed Substitute Senate Bill (ESSB) 5533 was the result. It became effective law on July 26, 1987. Of the $800,000 originally requested, the Legislature appropriated $400,000 to Washington Sea Grant to conduct the studies mandated by this law.

Why Sea Grant? First, the University of Washington has a renowned College of Ocean and Fishery Sciences, and Sea Grant is an effective pathway to that expertise. Second, Sea Grant is experienced in interdisciplinary research design, procurement, and administration. Third, Sea Grant has a communications network with other universities, giving Washington State quick access to nationwide expertise. Fourth, part of Sea Grant's mandate is to work with academe, government, and industry, without political advocacy, in a non-regulatory, information-support role. Last, Washington does not practice statewide planning, and assigning responsibilities of ESSB 5533 to a mission-oriented state agency might have created concerns over objectivity and fairness.

This law is ocean information oriented, as compared to Oregon's C-ESB 630, which is ocean management oriented. Management could be the next step for Washington State. Through its Ocean Resources Assessment Program (ORAP), Washington Sea Grant is synthesizing existing scientific information. The Legislature's Joint Select Committee on Marine and Ocean Resources acts as oversight committee for ORAP. In the 1989 Legislative session, convening in January, ORAP is to report its findings about information gaps and research needs and to present a plan for future studies.

In designing ORAP, an overall guideline was the determination to benefit from the experience of others and to not duplicate past and current studies. Thus, ORAP has sponsored little original research but has concentrated on synthesis and planning. ORAP consists of seven projects, including the study from which this book is derived:

• **An Advisory Committee,** as required by law. Sea Grant recognized the need for broad educational base-building among the policy-makers in state and local governments, tribal authorities, and citizen groups. Ten legislators, equally split by party and body, were members of this advisory committee. Sea Grant devised an innovative approach to help the 32 members of this committee educate themselves quickly about the offshore oil and gas industry and its typical facilities, equipment, operations, and impacts. The committee functioned like a task force and reported to Sea Grant on information needs and priorities. This project is a worthy model for others who must deal on a tight schedule and budget with new, complex issues of high public concern.

• ***State and Local Influence Over Offshore Oil Decisions***—a study of the roles and mechanisms of state and local governments in offshore oil decision-making, as revealed by experience in other states.

• **Hydrocarbon Potential of the Washington OCS**—an assessment by the Washington Department of Natural Resources, to help identify geologic formations that might be of potential interest to industry.

• ***Coastal Oceanography of Washington and Oregon***—a regional oceanography text, making contributions to science on 15 of the 22 subjects mentioned in the law. Multi-edited and authored, the hardcover book presents the results of many years of research. Sea Grant funded the final efforts needed to make the book available in time to influence OCS decision-making and future research.

• **Conceptual Framework for Future OCS Research**—a workshop to develop a framework to help determine "what's important?" and ensure that future research is both targeted and well-founded scientifically.

• ***Coastal Washington: A Synthesis of Information***—a report on existing information, information gaps, and research needs.

• **OCS Studies Plan: A Report to the Washington State Legislature**—a plan developed by Washington Sea Grant, as required by law, building upon the other ORAP projects and other studies.

Washington Sea Grant is publishing reports of each of these projects, except for the coastal oceanography text, which is being published commercially by Elsevier Science Publishers. Meanwhile, the Legislature's Joint Select Committee on Marine and Ocean Resources is grappling with statewide policy alternatives and may propose legislation for the 1989 regular session.

B. Glenn Ledbetter, Manager, ORAP
November 1988

Preface

In establishing the Ocean Resources Assessment Program (ORAP), the Legislature sought to enhance the State of Washington's readiness to deal with offshore oil and gas development that could move ahead during the 1990s if federal Lease Sale 132 takes place. The activities of the ORAP Advisory Committee, summarized in this volume, have done much to enhance the understanding of key legislators, agency representatives, and leaders of non-governmental and local government groups about the process and consequences of offshore development. This report highlights a number of important issues which must be addressed if state and local governments and existing users of the ocean are to deal with lease proposals in a knowledgeable and effective manner.

In addition to the issues discussed in the body of the report, the ORAP Advisory Committee, at its final meeting, made the following recommendations:

- We urge the Legislature and Governor to continue providing leadership to support the systematic preparation of the state, its local governments, communities, and citizens to be full and effective participants in the Minerals Management Service leasing process. In so doing, the Governor and Legislature should evaluate the needs for information and analysis at each step in the process to ensure the prudent and efficient use of scarce resources.

- We encourage the state and local governments which share special responsibilities for the waters off Washington to take steps to develop the information and policies necessary to:

  Ensure that any oil and gas activities are carried out in a way that protects the physical, social, and economic environment of our state;

  Ensure that temporary activities such as oil and gas production do not impair the natural resource base that supports the continuing economy of the coastal areas;

  Ensure effective joint decision making whenever needed;

  Initiate governmental actions and processes at the appropriate times and maintain a steady course of actions so as to maximize their ability to represent the interests of the state's citizens during the leasing process;

Look beyond the immediate issues surrounding Lease Sale 132, in order to prepare for other potential uses of the ocean off Washington.

- We encourage state-wide dissemination of public information and educational material focused on the oil and gas leasing process, since the best decisions at all levels of governance are made in the presence of a well-informed population.

G. Ross Heath, Chair
ORAP Advisory Committee
September 1988

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Washington Sea Grant Program • University of Washington

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Acknowledgments

This report would not have been possible without the active and enthusiastic participation of the members of the Ocean Resources Assessment Program (ORAP) Advisory Committee and the cooperation of the hosts of the meetings and field trips.

The Committee expresses its immense appreciation to all the public officials, companies, organizations, and individuals who generously shared information, time, and hospitality with Committee members. The willing support of so many people allowed the Committee and, consequently, the people of Washington state to obtain the broadest possible background and knowledge of offshore oil and gas exploration, development, and production in the very brief time available.

Certain individuals made extraordinary commitments of time and effort to the ORAP Advisory Committee. Special gratitude is expressed to John Richards, California Sea Grant Marine Advisory Service, who contributed amply to each California trip; Del Fogelquist, Western Oil and Gas Association, and Denny Samuel of Chevron U.S.A. and the Western Oil and Gas Association, who both made innumerable contacts in industry and generated support for tours of offshore and onshore sites; and Jim Owens, Rowan Companies, who helped organize the itinerary and dedicated three complete days to hosting the members who traveled to Texas; and Bob Butts, staff to the Legislative Joint Select Committee on Marine and Ocean Resources, who coordinated a trip by some members to California while others were in Texas and Alaska.

The Committee also appreciates the Washington Sea Grant Program staff, who provided education, materials, and support for its work. Special acknowledgments are due to Ross Heath, Glenn Ledbetter and Carolyn Pendle. Dean Heath chaired the Committee with superb leadership, diplomacy, and skill. Mr. Ledbetter conceived and managed the Advisory Committee project. Both he and Ms. Pendle organized the field trips, which were invaluable educational experiences, and shepherded the Advisory Committee through its busy schedule. Ms. Pendle staffed the Committee professionally and is the "ghost author" of this report. Her interpersonal skills, coupled with untiring efforts, have produced a report which captures the thoughts, experiences, and ideas of this diverse group in a very usable way. The capable editing services of Patricia Peyton and her communications staff were essential in completing the final report. Randal Hunting provided excellent illustrations.

Through the efforts of these people and many others too numerous to mention here by name, our work is presented to Washington Sea Grant with the hope that it will appeal also to all readers interested in offshore oil and gas.

Executive Summary

In 1992 the federal Minerals Management Service (MMS) plans to begin leasing outer continental shelf (OCS) areas off the Pacific coast of Washington for oil and gas exploration and development. Since the state currently has no offshore oil and gas development, the Washington State Legislature was concerned that the state needed more information available to decision makers. Thus, the Legislature asked the Washington Sea Grant Program (WSG) to analyze available information, identifying:

- existing information
- information gaps
- needed research

In turn Sea Grant established the Ocean Resources Assessment Program (ORAP) and asked the ORAP Advisory Committee to study offshore oil and gas exploration and development, to learn what it could from the experience of other states, and to identify and evaluate what topics most need attention in Washington—the information priorities.

The Advisory Committee brought together members of the state legislature, state agency officials, representatives of local and tribal governments, and a variety of people from interested public and private organizations. The broad experience and expertise of its members allowed the Committee to reflect the concerns and needs of the people and governments in Washington. ORAP asked the members to use their collective insight in evaluating information gaps and research needs.

Purpose and Scope of the Report

The *Final Report* of the ORAP Advisory Committee explains the process and Committee findings and identifies information the Committee believes most important to Washington. As charged, the Committee recommends information priorities and research needs, but leaves policy recommendations to other forums. These information priorities are presented to Washington Sea Grant, which must develop a detailed studies plan for presentation to the Legislature.

In addition to documenting the Committee's experience, this report can help orient other people unfamiliar with offshore oil and gas issues. A separate unpublished document, *Reports of ORAP Advisory Committee Members and Subcommittees*, contains individual trip reports of members and reports of ORAP subcommittees and presentations. It includes much more diverse detail than this general Committee report.

Understanding the Full Context of OCS Oil and Gas Exploration and Development

Understanding the implications of OCS oil and gas development requires that the state understand the full environment that surrounds and encompasses the industry and affected communities. In this report the Advisory Committee presents what it learned about the Minerals Management Service lease sale process, the offshore oil and gas industry, and the concerns identified for Washington state. (Another ORAP report, *Coastal Washington: Synthesis of Information*, provides readers with additional background information on the environment and socio-economic systems of the Washington state offshore and coastal areas.)

The OCS leasing process involves many parties and activities. While the process is federally determined and controlled, it does allow for input from affected states. In order for Washington to participate effectively, people must understand the existing roles and participants. The question of whether exploration and development actually occur depends on how much interest private enterprise has in exploring and developing the tracts available. Thus, people interested in the result must learn about the offshore oil and gas industry and about the role that Washington state can play in OCS oil and gas leasing:

Decision Making. Chapter 2 of this report describes the existing statutes, regulations, entities, and the federal OCS lease sale process.

The Offshore Oil and Gas Industry. Chapter 3 describes the offshore petroleum industry, particularly during the significant phases of exploration, development, and production.

Defining the role of Washington state in the OCS lease sale process also requires looking at the state's alternative futures.

Case Study Scenarios. Chapter 4 explains how the Committee was asked to imagine future development alternatives through consideration of two hypothetical exploration and development scenarios.

Committee members' full, collective knowledge of Washington state, its local communities, counties, and tribes, local industries, local environment, local values then allowed them to apply to Washington their newly acquired knowledge of the lease sale process, the industry, and the impacts of OCS oil and gas leasing in areas of hydrocarbon development.

Information Demands, Gaps, and Research Needs. Chapter 5 explains the information concerns identified by the Committee, based on members' knowledge of the activities that occur during each phase of development and on the needs, values, and priorities of the people of Washington. Understanding what the state needs to know during the post-lease stages of exploration, development, and production allowed the Committee members to infer what information is needed during the pre-lease phase. Many of the Committee's ideas developed from members' travel—from information provided by people and groups with experience in offshore oil and gas exploration, development, and production.

The concerns identified in this report fall into five classifications:

- *Environment*—possible impacts to the natural environment
- *Use conflicts*—possible impacts to existing uses of the environment or the offshore area
- *Community decision making*—impacts on and responses required of organized groups or governments
- *Personal and interpersonal*—impacts that affect individuals or relationships between individuals (animosity, goodwill, aesthetics, value changes)
- *Safety and risk*—concerns about safety and risk, including risk assessment, perception, communication, and management

These concerns subsequently generated the information and research needs noted in Chapter 6. Advisory Committee members, working in subcommittees and the full Committee, agreed that certain kinds of information were critically important to the state.

The Information Priorities. Chapter 6 presents the information most necessary to ensure the state is ready to make effective decisions on offshore oil and gas. The list distinguishes between the information needed first, in the pre-lease phase, and later, in the post-lease phase.

FINDINGS: WHAT WASHINGTON NEEDS TO KNOW

The ORAP Advisory Committee evaluated information needs based on (1) the importance of each subject to Washington state and (2) timing (when in the leasing process the information is needed). Also pertinent are the likelihood of impact and the perceived level of knowledge about a subject. The information priorities, all of great importance to the state, are explained more thoroughly in Chapter 6. Some of the information priorities require formal research; some require synthesis and analysis of existing information; others require action or decision making based on available information.

PRE-LEASE INFORMATION PRIORITIES

Because the planning area off Washington and Oregon for Lease Sale 132 is so large, pre-lease studies should be broad-based surveys, accumulating information that could apply to whatever specific areas are subsequently identified for oil and gas development. Studies should aim to achieve multiple objectives. Conversely, if offshore petroleum development does not proceed, the completed studies should create a base of knowledge useful in understanding other potential events that could affect natural and socio-economic systems in the state. The following topics are most important during the pre-lease phase. The first items require information gathering, analysis, and possible action; the last three topics are essentially action items, requiring available information for decision making:

- Existing natural environment
- Washington fisheries

- Jurisdictional issues
- Locations of potential development
- Existing socio-economic systems
- Use conflicts
- Navigation and shipping
- Ocean dynamics
- Documentation of existing air and water quality
- Identification of risks
- Information management

The action items, requiring available information for decision making, include:

- Lease stipulations
- Assisting local governments
- Organizing and coordinating decision making

POST-LEASE INFORMATION PRIORITIES

After a lease sale occurs, the locations for potential development are defined, so there is a need for increasingly specific information. Rather than providing background and baseline information, studies must increasingly provide guidance for choices or decisions that must be made.

Topics that are especially important to Washington during the post-lease, pre-development phase include:

- *Environment*, with studies concentrating on understanding the species and habitats most vulnerable to impacts from petroleum development and on mitigation of impacts.
- *Risk/benefit assessment*, taking into account the specific oceanography, geography, and population of sites under consideration.
- *Economic assessments* to determine the economic benefits and costs of offshore oil and gas development and production.
- *Assessments of community needs* as a foundation for siting and economic development decisions.
- *Information for siting, permitting, and policy decisions* (environmental, oceanographic, socio-economic, risk information, etc.).
- *Conflict resolution* to resolve use-conflict issues.
- *Spill containment*, including prevention, cleanup, and use of dispersants.

The topics that are essentially action items, requiring available information for decision making, include:

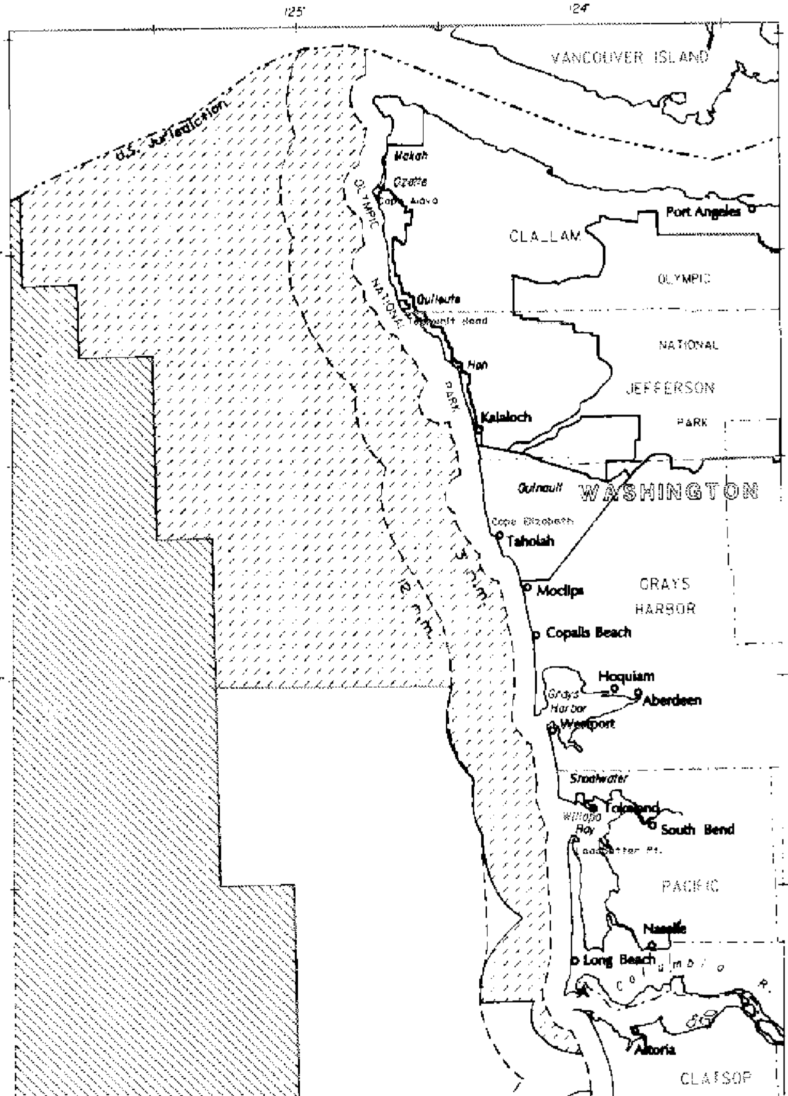
- *Information for monitoring, regulating, and enforcing* so that the state can protect its environment and population.

WHY IS THIS INFORMATION SO IMPORTANT?

Three characteristics of the offshore oil and gas industry make it particularly important to the people of Washington that the state be prepared with adequate information to make good decisions at all levels. First, offshore oil and gas development is very high technology, with low-probability, high-consequence risk. In certain regions, the public is often reluctant to accept operations of such industries. Second, the coastal areas that would be affected by offshore oil and gas depend heavily on resources of the coastal area (fish, timber, scenic and recreational beaches, clean air, etc.) for their long-term survival. Thus it is important that the comparatively short-term offshore oil and gas industry not permanently harm these vital resources. Third, the industry's uneven distribution of risks and benefits, with those people who live near the development bearing most of the risk and few of the benefits, makes it crucial that local decision makers be well prepared to represent local interests.

The ORAP Advisory Committee has become informed about the OCS lease sale process and the oil and gas industry, and has carefully considered local concerns and needs. These topics are critical to Washington's decision making on OCS oil and gas activities. The Committee presents these priorities to Washington Sea Grant to use in developing a plan for future studies.

LEASE SALE 132—WASHINGTON AREA



Scale

0 — 20

nautical miles

Subarea Deferrals

Highlighted Areas

Ocean Resources Assessment Program

WASHINGTON SEA GRANT

1

ORAP Advisory Committee

In 1992 the federal Minerals Management Service (MMS) plans to begin leasing outer continental shelf (OCS) areas off the Pacific coast of Washington for oil and gas exploration and development (Figure 1.1). Currently, Washington state has no offshore oil and gas development.

Introducing a new industry in or near the coastal communities would impact existing environmental and socio-economic systems, causing possible benefits or conflicts. Any of these changes would raise many questions and opportunities for decisions.

Because of its concern that the state have a solid base of information available to decision makers if the leasing program is implemented, the Washington State Legislature asked the Washington Sea Grant Program (WSG) to analyze available information, identifying:

- what relevant data and information are already available
- where information gaps exist
- what studies are needed in the future

This project, the Ocean Resources Assessment Program (ORAP), then asked the ORAP Advisory Committee to study offshore oil and gas exploration and development, to learn what it could from the experience of other states, and to identify and evaluate what topics need attention in Washington. (Refer to Appendix A, ESSB 5533, and Appendix B, Description of the ORAP Advisory Committee.)

Committee Makeup and Activities

The Advisory Committee brought together members of the state legislature, state agency officials, representatives of local and tribal governments, and a variety of people from interested public and private

Figure 1.1 The Lease Sale Area. (Left) Off the Washington coast, Lease Sale 132 extends from 3 to about 40-50 miles offshore. MMS has deferred indefinitely leasing in the deep-water section (out to 200 miles) because of technical difficulties and high costs relative to expected return. MMS has "highlighted for additional studies" other areas that the Governor of Washington has sought to have excluded from lease sales—the areas within 12 miles of environmentally sensitive bays and north of the 47th parallel. A recent law authorizing the National Oceanic and Atmospheric Administration to designate a marine sanctuary off the north coast adds emphasis to the State's petition and the MMS decision requiring further study.

organizations. Among the group were representatives of Minerals Management Service, oil industries, supply base industries, Washington ports, an environmental group, commercial fishing, and recreational fishing. The broad range of experience and expertise of its members allowed the Committee to reflect the varied concerns and needs of the people and governments in Washington. ORAP asked the members to use their collective insight to evaluate information gaps and research needs.

The Advisory Committee formed four subcommittees to study different dimensions of the OCS oil and gas industry: exploration, offshore, onshore, and transshipment (Appendix C). The Exploration subcommittee focused on all aspects of offshore oil and gas exploration. The Offshore subcommittee studied offshore aspects of OCS oil and gas development and production, while the Onshore subcommittee concentrated on onshore activities and effects during the same two phases. The Transshipment subcommittee focused on aspects of transporting oil and gas.

Offshore oil and gas—as a technology and as the process of development—is a complicated issue. To allow Committee members to become proficient in their assigned subjects, members traveled to locations that have existing offshore oil and gas development and production. By touring facilities at these locations (Appendix D, Sites Visited) and by talking to representatives of industry, government, and the public, Committee members quickly developed expertise in OCS oil and gas issues. A separate unpublished document, *Reports of ORAP Advisory Committee Members and Subcommittees*, contains individual trip reports of members and reports of ORAP subcommittees and presentations. That document holds considerable detail, color, and intriguing observations.

Each subcommittee presented its findings to the full Advisory Committee. The Committee's findings identify what information the Committee believes most important to Washington.

The Advisory Committee attempted to understand the full environment that surrounds and encompasses the OCS oil and gas industry and affected communities. Committee members studied the decision making process and the offshore oil and gas industry. Hypothetical case study scenarios challenged members to consider different futures for Washington state. Another ORAP report, *Coastal Washington: A Synthesis of Information*, provides readers with additional background information on the environment and socio-economic systems of Washington state. Appendix E also lists relevant research projects.

The OCS leasing process involves many parties and activities. The process is federally determined and controlled, but provides for input of affected states. Washington state wants to maximize the impact of its participation in the federal process.

Whether the actual exploration and development phases occur depends to a great extent on the amount of interest private enterprise has in investigating the tracts MMS makes available for leasing. Again, to participate effectively in the process, state government, local governments, and citizens must understand the oil and gas industry.

Because offshore oil and gas is a complex issue, the list of Acronyms and Abbreviations (Appendix F) and the Glossary (Appendix G) will aid the reader's understanding of the technology and the processes involved.

THE COMMITTEE'S PRODUCT

Committee members' full, collective knowledge of Washington state; its local communities, counties, and tribes; the local industries; the local environment; and the local values then allowed members to apply what they learned to situations within Washington. Certainly, members' ideas primarily evolved from discussions with people experienced in offshore oil and gas. However, the strength of the Advisory Committee was its ability to evaluate information in terms of Washington state or local areas. The concerns that the Committee identified generate the information demands—information needed to resolve each concern. Further, by comparing the known concerns with current information available, the research needs and priorities become apparent. Thus, the concerns identified by the Committee in Chapter 5 generate the priorities for information and research noted in Chapter 6.

It is important to understand that this assessment represents the views of this particular group of people with respect to the issues at this particular time. As individuals learn more, as technology develops, and as external conditions change, their views are likely to change as well. However, the breadth of interests, backgrounds, and perspectives of the Advisory Committee members gives this assessment stability for several years.

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Decision Making

Coastal states have a variety of means for participating in the OCS decision process. Ultimate decision authority, however, remains with the Secretary of Interior. To exercise what leverage it does have, the state must carefully understand the process and the roles of each entity involved in decision-making. Only then will the state be able to maximize the effect of its own involvement in the leasing process.

The primary participants in the OCS lease sale process are the Minerals Management Service (MMS, U.S. Department of the Interior) and private oil and gas companies. However, many other governmental units, at a variety of levels, contribute to the process. This chapter explains the most relevant statutes and rules that affect offshore oil and gas leasing, the entities involved, and the existing leasing process. For analysis of and lessons learned from case studies, see the sister report on *State and Local Influence Over OCS Decisions* in this ORAP series.

Statutes & Regulations: What are the Rules?

Whether on the federal, state, or local level, policies are normally framed by general legislation, with more specific administrative rules and regulations developed to implement the policies. Occasionally, executive orders drive the other processes.

In an ideal world, comprehensive policies would guide specialized uses of a major resource such as oil and gas or the ocean environment. However, there is neither a comprehensive energy nor an ocean policy in the United States. In the absence of overall policies to link the specific policies, the individual laws and regulations are sometimes inconsistent. As a consequence, different agencies function under diverse statutes and regulations, making planning and coordination difficult.

Furthermore, crisis can drive the development of federal policies controlling oil and gas development. The energy crisis of the mid-1970s placed great power in the federal process at the expense of state and local government participation in leasing and development decisions.

The following policies are relevant to offshore oil and gas leasing, exploration, development, or production.

FEDERAL

- The *Outer Continental Shelf Lands Act (OCSLA or OCS Lands Act, 1953)* established U.S. jurisdiction over mineral resources in the zone from 3 miles offshore to the limit of the outer continental shelf. This "topographic" boundary may be compared to the 200-nautical mile geographic boundary established in the Exclusive Economic Zone proclamation of 1983. The act establishes policies to encourage the development of oil and gas resources and directs the Secretary of Interior to conduct a leasing program for exploration and development rights in the OCS.

OCSLA Amendments in 1978 set up the Department of Interior's current, 5-year process for managing OCS lease sales for oil and gas development. The amendments authorize coastal states to make "recommendations" about the "size, timing, and location" of lease sales, and require the Interior Secretary to respond in writing to the governors about the rationale for accepting or rejecting the recommendations. Also, 1978 amendments established the oil spill pollution compensation fund and fishermen's contingency fund.

Amendments signed in 1986 (Section 8(g), OCSLA) provided that coastal states should receive 27 percent of the federal revenue earned in the 3-mile strip of OCS lands immediately seaward of the 3-mile strip of coastal waters that are under state jurisdiction. This transfer payment was negotiated in part because drilling in the area from 3 to 6 miles offshore could drain resources from within the state's boundary.

- The *Submerged Lands Act (1953)* gave coastal states full ownership of the seabed within 3 geographic miles of shore (in the Gulf of Mexico, 3 marine leagues, or about 10 miles). Thus states may conduct their own leasing program for mineral resources in state waters, also known as the territorial sea.

- The *National Environmental Policy Act (NEPA, 1969)* requires the federal government to prepare Environmental Impact Statements (EISs) for major federal actions. NEPA is particularly important in documenting potential impacts and the actions to mitigate impacts. An EIS is prepared for the 5-year program of DOI, for each lease sale and for individual development projects.

- The *Clean Air Act (1970)* establishes standards and a permit program for air pollutants. The OCSLA, however, gave air quality jurisdiction for OCS oil and gas activities to DOI. States and the Environmental Protection Agency exercise control in the territorial sea and onshore.

- The *Coastal Zone Management Act (CZMA, 1972)*, which was designed to protect coastal areas, provides for state and local planning and management and requires that federal actions be consistent with approved state coastal management programs. CZMA provides the state with the greatest potential to influence OCS exploration and development decisions through its consistency review of drilling permits. The Act is administered by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce.

  CZMA used financial incentives to encourage states to develop coastal zone management plans, then promised that all federal activities that directly affect a state's coastal zone would have to be consistent with federally approved state coastal programs. In 1976, Washington was the first state to have its Coastal Zone Management Plan approved under this Act.

  Amendments to the CZMA in 1976 adjusted the law to account for environmental concerns and established the Coastal Energy Impact Program (CEIP), which provided financial assistance to states to use for coastal management purposes. CEIP monies are no longer available because Congress stopped appropriating money to continue the program.

  In 1984 the U.S. Supreme Court ruled that OCS lease sales do not "directly affect" the coastal zone, so that states no longer can rule on consistency of lease sales under Section 307(c)(1). However, after the sale, Section 307(c)(3) still gives the states specific consistency review of the successful bidder's exploration, development, and production plans. There have been attempts in Congress to liberalize the language "directly affects" to "significantly affects."

- The *Rivers and Harbors Act of 1899* designates the U.S. Army Corps of Engineers as the federal regulatory agency for matters related to construction in, or discharge into, navigable waters. Regulated facilities and operations include piers, berths, artificial reefs, bridges, offshore rigs, platforms, channel dredging, and spoil disposal, especially as related to navigation.

- The *Clean Water Act (Federal Water Pollution Control Act and Amendments, 1972)* establishes standards and a permit program for point source discharges of pollutants; establishes liability for oil spills and provides for federal cleanup efforts through a National Contingency Plan; and requires the U.S. Army Corps of Engineers to permit for discharges of dredged fill material into navigable waters or wetlands. For discharges from oil and gas operations, the U.S. Environmental Protection Agency issues general or individual permits under the National Pollutant Discharge Elimination System (NPDES).

- The *Endangered Species Act (1973)* requires that federal actions not jeopardize species that are listed as endangered or threatened. Where such species are present, either the National Marine Fisheries Service or the U.S. Fish and Wildlife Service must evaluate potential impacts from OCS operations.

- The *Magnuson Fishery Conservation and Management Act (MFCMA, 1976)* expanded federal fisheries management authority from 12 to 200 miles offshore and created regional councils to assist in preparing and implementing Fishery Management Plans.

- The *Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or "Super-Fund," 1980)* encourages state and local oil spill contingency plans, establishes a cleanup fund and defines its use. Petroleum products are not considered hazardous substances under the act, but CERCLA regulations and procedures may be applied to releases of petroleum through the authority of the Clean Water Act.

- The *Ports and Waterways Safety Act (1972)* protects navigational safety throughout the navigable waters of the United States. The U.S. Coast Guard establishes and maintains vessel traffic lanes and mandatory communications services.

- The *National Park Service Organic Act (1916, amended 1958)* applies to tidelands owned by the Olympic National Park.

- The *Marine Mammal Protection Act (1972)* prohibits the "taking" of marine mammals, except by permit of the National Marine Fisheries Service. Thus, OCS activities must be evaluated for potential impacts to these animals.

- The *National Historic Preservation Act (1966)* provides for the designation and protection of historic and prehistoric archaeological resources, including onshore sites and submerged shipwrecks or submerged archaeological sites. Federal actions must be evaluated for potential impacts to such resources.

- The *Marine Protection, Research, and Sanctuaries Act (1972, amended 1988)* requires the Secretary of Commerce to issue a notice of designation with respect to the Western Washington Outer Coast National Marine Sanctuary not later than June 30, 1990.

- In the *Exclusive Economic Zone (EEZ, 1983)* proclamation, President Reagan proclaimed that the area from 3 to 200 nautical miles from the coast is an Exclusive Economic Zone, in which the U.S. asserts sovereign rights and jurisdiction over seabed minerals, oceanic energy production, and all species of fish (except tuna).

- *Congressional spending moratoria* have essentially stopped leasing activities in large areas by banning MMS expenditures. Thus "backdoor" procedures—using the appropriations process and overriding the usual planning and regulatory process—influence which areas are leased and explored and which are not. Moratoria have occurred because the delicate compromises negotiated among the federal government, the states, industry, and environmentalists in OCSLA amendments have not worked to everyone's satisfaction. Congressional actions reflect the dissatisfaction that persists.

WASHINGTON STATE STATUTES

State statutes have not yet explicitly addressed the OCS oil and gas leasing issue. However, there are several relevant acts:

- The *Shoreline Management Act (SMA, RCW 90.58)* is administered by the Department of Ecology. The detailed zoning is a local governmental responsibility embodied in the local shoreline master programs. Ecology, which originally reviewed and approved local governments' shoreline master programs, maintains supervisory authority and monitors permits issued by local governments. SMA emphasizes environmental protection in the management of state-owned aquatic lands, with a preference for long-term over short-term benefits. It applies from the shoreline seaward 3 miles and inland for 200 feet. In 1983, the SMA was amended to provide DOE with authority for issuing permits for oil or natural gas exploration activities conducted from state marine waters.

- The *Energy Facility Siting Act (EFSA, RCW 80.50)* creates and authorizes the Energy Facility Site Evaluation Council, a quasi-judicial regulatory body. The Council serves as a one-stop agency for permitting major energy facilities within the state.

- The *Public Lands Act (Oil and Gas Leasing on State Lands, RCW 79.14)* authorizes the Commissioner of Public Lands to lease or not lease state-owned lands (which include those within 3 miles of shore), depending on the state's benefits; the Act sets terms and conditions of leases, and embodies a preference for development once leases are made.

- The *Aquatic Lands Act (RCW 79.90)* provides the policies under which the Department of Natural Resources manages all state-owned aquatic lands, emphasizing a balance of benefits to all state citizens, water-dependent uses, and environmental concerns.

- The *State Environmental Policy Act (SEPA, RCW 43.21)* requires that an environmental impact statement (EIS) be conducted for oil and gas related facilities located within state jurisdiction.

- The *Seashore Conservation Area (RCW 43.51.650)* establishes public recreation areas along Washington's Pacific Coast.

- The *Water Pollution Control Act (RCW 90.48)* creates a pollution control commission to control and prevent pollution of Washington waters.

- The *Fisheries Code (RCW 75)* provides management guidelines for food fish and shellfish and authorizes the Department of Fisheries to protect and manage recreational and commercial fisheries. The Act also authorizes the Department of Fisheries, jointly with the Department of Wildlife, to administer the Hydraulic Code, requiring that construction projects in state waters obtain a permit from either WDF or WDW to ensure protection of fish, shellfish, and wildlife resources of the state.

- The *Oil and Gas Conservation Act (RCW 78.52)* provides for the regulation of oil and gas drilling, production, storage, transportation, and refining operations within Washington State. It also provides for the confidentiality of "wildcat" or exploratory well data.

- *The Planning Enabling Act (RCW 36.70)* enables counties to form planning commissions and counties, cities, and others to form regional planning commissions. Comprehensive planning and zoning requirements are established. Among the elements of the comprehensive plan are land use, circulation, conservation, recreation, transportation, and public services and facilities.

making this a very important document for control of onshore oil and gas facilities and operations.

Local policies are set primarily by local governing bodies such as county commissions, port authorities, and air pollution control districts.

JURISDICTION: WHO ARE THE PARTICIPANTS?

Oceans are immensely important to the United States—they provide abundant natural resources, ranging from oil and gas to fish and mammals. Oceans are used for transportation, for defense, for waste disposal, for pleasure. Because of the wide-ranging interest in oceans, ocean policy-making is complicated and must take into account many different entities. These different groups, often of different levels (federal, regional, Indian, state, local), must work together in networks defined by particular issues and by the responsibilities and authorities for those issues. New issues often prompt creation of new task forces, designed to link those agencies, states, or federal-state entities required to deal with them.

Thus, many federal, regional, state, and local entities are involved in the process of oil and gas leasing. Some have major roles, some minor. The following descriptions highlight important roles of several major groups involved.

FEDERAL LEVEL

- Through major acts, *Congress* negotiates and sets the general policies for offshore oil and gas development, particularly the aspects that relate to income and expenses and to the balance between development and conservation values. The federal policy largely recognizes state jurisdiction for activities occurring within state boundaries and maintains fairly tight control of activities in federal waters.

- The *Department of the Interior* is charged in the OCS Lands Act to manage the "expeditious and orderly development" of OCS resources in accordance with the "national interest and protection of the human, marine, and coastal environments." The Secretary of the Interior has delegated much of the management to the *Minerals Management Service (MMS)*. MMS is also responsible for the revenue-raising aspect of OCS development. MMS regulates oil and gas drilling and producing operations. As specified in the amendments to the OCS Lands Act, the MMS has a five-year lease sale process that is designed to allow for scientific studies and public participation. MMS has an OCS Advisory Board that provides policy, technical, and scientific advice on the OCS program. The size and complexity of the OCS management and leasing responsibility can make active participation difficult.

- The *Environmental Protection Agency (EPA)* establishes and regulates air quality standards within the 3 mile limit only. Beyond 3 miles from shore, Interior regulates air quality, even though it also sponsors the projects. EPA is also involved with issuing general permits for the lease sale areas and issues permits for waste discharges into the water from exploration, production, and transport of oil or gas.

- The *Department of Transportation (DOT)* regulates occupational safety and health as well as the design of pipelines and mobile drilling vessels. Through the *U.S. Coast Guard (USCG)*, it responds to emergencies, cleans up oil spills if the party responsible for the spill cannot or does not, inspects vessels, and recommends shipping lanes to the International Maritime Organization (London).

- The *Army Corps of Engineers* (COE) must approve the placement of platforms and issues permits for dredging and for waste discharges into the water within the three mile zone and adjacent to shipping lanes.

- The *National Oceanic and Atmospheric Administration (NOAA)* in the Department of Commerce (DOC) administers the Coastal Zone Management Act and the National Marine Protection, Research and Sanctuaries Act through its Office of Ocean and Coastal Resource Management within the National Ocean Survey (NOS). NOAA's National Marine Fisheries Service (NMFS) administers the Marine Mammals Act and aspects of the Endangered Species Act.

- The *National Park Service* manages the national parks, including the Olympic National Park, which includes part of the Washington coast.

- The *U.S. Fish and Wildlife Service* manages several national wildlife refuges along the Washington coast and has responsibilities for review under the Endangered Species Act.

- The *Coastal States Organization (CSO)* is an association that promotes the interests of 35 coastal state and territorial governors in United States coastal affairs.

- National and regional associations, such as the *National Governors' Association*, the *Association of Attorneys General*, the *National Council of State Legislatures*, and the *Western*

Legislative Conference provide indirect but useful coordination of state policies.

REGIONAL LEVEL

- The *Pacific Fisheries Management Council* is a regional council composed of federal and state fisheries agencies and private representatives responsible for fisheries management in the 3-to-200-mile zone. Fisheries Management Plans developed by the Council are implemented by the National Marine Fisheries Service.

- The *Northwest Indian Fisheries Commission (NWIFC)* and the *Columbia River Intertribal Fish Commission* are associations of Indian tribes with interests in fisheries and fisheries management. (Table 2.1 indicates the Washington tribes affiliated with each group.)

- The *Washington/Oregon OCS Technical Advisory Group* is a group of scientists and specialists from resource management agencies and universities in the two states who monitor OCS environmental studies, assess research needs, and evaluate ongoing MMS sponsored research.

- The proposed *Pacific Northwest Outer Continental Shelf Task Force* would include representatives from the Department of the Interior, the states of Oregon and Washington, the Northwest Indian Fisheries Commission, and Columbia River Intertribal Fish Commission.

STATE AND TRIBAL GOVERNMENTS

- The *Governor* has appointed an OCS working group within the executive branch to develop policy recommendations concerning offshore oil and gas development. By statute, the governor and lieutenant governor both serve as members of the state's Oil and Gas Conservation committee.

- *Washington State Legislature:* The *Joint Select Committee on Marine and Ocean Resources* is the primary legislative group addressing OCS oil and gas. The Committee has its own OCS advisory group.

- *Washington State Agencies:*

  Department of Ecology administers the Shorelines Management Act and has been designated by the Governor as the lead agency for OCS leasing matters.

Energy Facility Site Evaluation Council includes representatives from 13 state agencies and a local representative as appropriate. The Council was created as a one-stop agency for permitting major energy facilities within the state. The council is a formal regulatory body which acts as the lead agency for the state EIS process for energy facilities, conducts quasi-judicial reviews of project proposals, and makes formal recommendations for gubernatorial action on these matters.

Department of Community Development works in partnership with the state's local governments and communities on a broad spectrum of issues of mutual interest. In the case of OCS development, DCD jointly assesses local issues, develops mitigation strategies, and seeks to implement these strategies with its local partners.

Department of Fisheries protects and manages the state's food fish and shellfish resources. Under that general authority, the department manages major recreational and commercial fisheries as well as protect habitats. The director of the department also serves as an ex officio member of the Pollution Control Commission.

Department of Natural Resources administers the state's ownership interest over the lands from low tide to three miles offshore, including authority for oil and gas leasing, and other aquatic land uses. The state land commissioner is an ex officio member of the Oil and Gas Conservation Committee.

Oil and Gas Conservation Committee includes the governor, the lieutenant governor, the land commissioner, and the state treasurer and is responsible for administering provisions of the Oil and Conservation Act.

Department of Trade and Economic Development is responsible for attracting business and industry to Washington and promoting business enterprises within the state.

Department of Wildlife reviews federal agency actions potentially affecting wildlife, recommends conditions on permits, and issues hydraulic project approvals for work within the three-mile limit.

Washington State Parks and Recreation Commission manages several developed state parks in the coastal area for recreation and preservation, and is the managing agency for the Seashore

Conservation Area, which includes all state-owned ocean beaches along the Pacific Coast.

Department of Agriculture coordinates aquaculture interests in the state. The director of the department also serves as an ex officio member of the Pollution Control Commission.

- *Treaty Indian tribes* are guaranteed by treaty the right to fish and manage fisheries in their "usual and accustomed places," which for some tribes extend well into OCS waters. They have special treaty rights to land, beaches, shellfish and fish. (Table 2.1 lists Washington Indian reservations that are federally recognized.)

REGIONAL AND LOCAL GOVERNMENTS

- *Cities and Counties* have primary responsibility for administering shorelines master programs and adopting other land use regulations. Counties and cities also decide land use and shorelines permits.

- *Regional Air Pollution Control Authorities* are responsible for monitoring and enforcing air quality standards established by federal and state Clean Air Acts.

- *Port Districts* are public enterprises which promote and facilitate economic development, commerce and navigation. Ports typically own and manage harborfront properties and facilities on which offshore operations rely. Most districts are members of the Washington Public Ports Association, which works to protect the interests of port authorities and access to facilities for port users.

LEASE SALE PROCESS: WHAT HAPPENS?

The MMS lease sale process is specified in the OCS Lands Act to provide a process that is predictable for oil and gas industries, for coastal states, and for any other entities or people who wish to participate. The process is designed to provide for more review and greater balance as well. The legislation requires the Secretary of the Interior to adopt a five-year leasing program that (1) balances the potential for discovery of oil and gas against the potential for environmental damage or adverse effects on the coastal zone, (2) balances among regions, and (3) provides fair-market value income. Each new five-year program is subject to comments from coastal state governors and localities, Indian tribes, the public, the oil and gas industry, environmental groups, affected federal agencies, and the Congress. Once Congress reviews the five-year program, MMS is responsible for carrying out the process, although Congress has sometimes withheld appropriations, thereby affecting the schedule. MMS, however, may delay

Table 2.1 Washington State Indian tribes that are reservation based and federally recognized.

Tribe	Location of tribal headquarters	Coastal tribe	Member NWIFC[1]	Member CRIFC[2]
Chehalis	Oakville			
Clallam	Sequim		X	
Colville	Nespelem			
Hoh	Forks	X	X	
Kalispel	Usk			X
Elwha	Port Angeles		X	
Lummi	Bellingham		X	
Makah	Neah Bay	X	X	
Muckleshoot	Auburn		X	
Nisqually	Olympia		X	
Nooksack	Deming		X	
Port Gamble	Kingston		X	
Puyallup	Tacoma		X	
Quileute	La Push	X	X	
Quinault	Taholah	X	X	
Sauk-Suaittle	Darrington		X	
Shoalwater	Tokeland	X		
Skagit	Sedro Woolley		X	
Skokomish	Shelton		X	
Spokane	Wellpinit			X
Squaxin	Shelton		X	
Stillaguamish	Arlington		X	
Suquamish	Suquamish		X	
Swinomish	LaConner		X	
Tulalip	Marysville		X	
Yakima	Toppenish			X

[1] Northwest Indian Fisheries Commission.

[2] Columbia River Intertribal Fisheries Commission

or cancel sales without having to go through the steps required to develop a new five-year program.

The current Department of Interior five-year plan—the one in which the Washington/Oregon Lease Sale 132 appeared--extends from July 1987 to June 1992. Official lease planning activity in Washington is

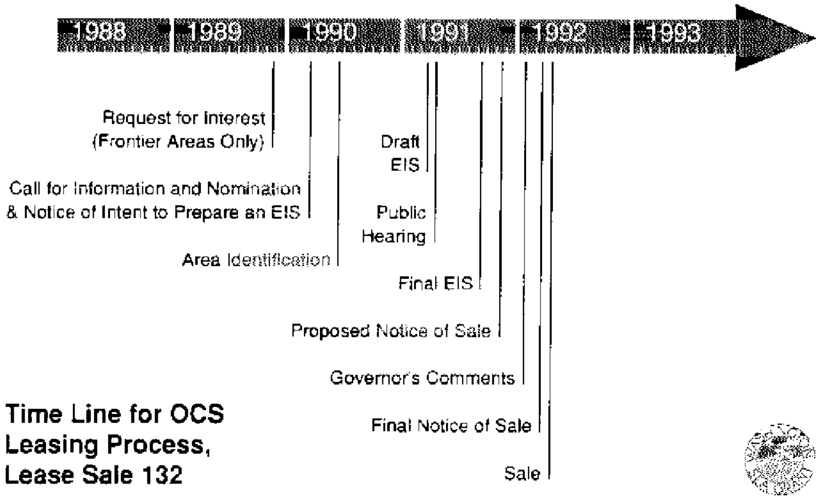


Figure 2.1 Schedule for the Ten Steps of Lease Sale 132.

scheduled to begin in November 1989 with a *Request for Interest* and to culminate in a *Lease Sale* in April 1992 (Figure 2.1).

FIVE-YEAR LEASE-SALE PROGRAM

For each lease sale scheduled in MMS's 5-year plan, there are certain steps and specified times for state and public response.

Lease sales in *"frontier exploration"* areas, as the Washington/Oregon sale is called, have a preliminary step called a *Request for Interest*. This step allows MMS to determine whether there is sufficient industry interest to justify the lease sale process. If there is not, the sale process may be discontinued.

If interest is indicated, a *Call for Information and Nominations* is issued. The call invites comments from states, potential bidders, and the public on levels of interest, concerns, and potential conflicts. Comments are usually due 45 days after the announcement is published in the *Federal Register*. At this time, coastal states also assess whether oil or gas pools that might be in the 3-to-6-mile zone could also underlie state-owned lands in the 0-to-3-mile zone.

MMS uses the information collected during the comment period to identify the area, issues, and alternatives to be studied for a subsequent EIS (EIS "scoping") and to determine subarea deletions. In the *Area Identification* step, MMS strives to include as much acreage with leasing and hydrocarbon potential as possible, so that it may be thoroughly analyzed. MMS usually deletes only areas where there is little interest and hydrocarbon potential or where special conservation designations have been made.

The next step is preparation of an EIS. First, MMS prepares a *Draft EIS (DEIS)*, which is filed with the EPA and announced in the Federal Register. Generally a 60-day period is allowed for comments, and at least one *Public Hearing* is held. MMS analyzes comments and information acquired and, when appropriate, incorporates them into the *Final EIS*, which is filed with EPA about 3 to 5 months after the public hearing.

One or two months after the Final EIS is filed and after additional decision materials are prepared, MMS issues a *Proposed Notice of Sale*. The notice identifies:

- blocks available for lease
- stipulations and other restrictions that would help mitigate potential environmental effects
- proposed bidding systems
- lease terms (number of years, etc.)
- other pertinent information.

MMS sends the governors of affected states a copy of the proposed notice and a letter explaining the decisions made. The governors then have 60 days to submit *Governors' Comments* on the size, timing, and location of the proposed lease sale. After MMS receives the governors' recommendations, it prepares a final decision memorandum for the Secretary of Interior. If the Secretary determines that the governor's recommendations provide a reasonable balance between the national interest and the well-being of an affected state, the recommendations must be accepted. The rationale for accepting or rejecting a governor's recommendations must be sent in writing to the governor.

If the decision is to proceed with the lease sale, the Secretary issues a *Final Notice of Sale*, which provides:

- date, time, and place of the sale
- blocks available for lease
- stipulations and other mitigating measures
- bidding systems
- lease terms
- other pertinent information

At least 30 days after the final notice is published in the *Federal Register*, sealed bids are publicly opened and read. Then bids are evaluated to determine their acceptability. The federal government, which reserves the right to reject any or all bids, must respond within 90 days of opening bids.

If a bid is accepted, MMS issues the lease after full payment of the bonus and the first year's fees. The lease grants the right to explore, develop, and produce oil and gas for a specific term and from a specific tract of OCS land. MMS typically restricts the initial lease term to 5 years, but may in "harsh environment" areas extend the terms to 10 years. For example, leases for blocks with water depths greater than 400 meters currently are issued for 10 years. Generally, in order to extend the lease term, a commercially valuable discovery of oil or gas must be found during the initial lease term. As long as there is production, the term remains in effect. On the other hand, if a lease does not have commercially valuable reserves, the lease reverts to the federal government at the end of the lease period, unless a suspension of operations is permitted.

When a company (or group of companies) obtains a lease, it has simply won the exclusive right to go through the process of applying for permits to explore the site. Yet the implications are greater, because if there is a *find*, the lessee is guaranteed the exclusive right to apply to develop and produce the petroleum.

EXPLORATION PLAN

Once the lease is let, MMS continues to manage activities on the OCS, reviewing plans and permits, as well as overseeing exploration, development, production, and shutdown.

In the early exploration phase, the company that obtains a lease will continue geophysical and geologic testing and will gather biological and cultural information necessary to develop a comprehensive plan for exploration. All drilling is prohibited until permits to explore and drill have been approved. Site-specific shallow hazards surveys are required to indicate whether geohazards or man-made hazards such as pipelines or shipwrecks could cause problems during development.

The lessee submits an *Exploration Plan*, which concisely describes the proposed offshore operations (Table 2.2). The Exploration Plan must be accompanied by an *Oil Spill Contingency Plan*, which describes the lessee's proposed response to an oil spill, and an *Environmental Report*, which assesses direct and indirect environmental impacts from the proposed oil and gas activities. This information provides the states with the necessary data and information to determine consistency under CZMA, and this certification must also be submitted by the lessee. When MMS determines that the submission is complete, it begins its technical review. Simultaneously, MMS forwards copies of the plans and reports to other federal agencies and to the governor and certain agencies of any affected state.

Table 2.2 Documentation required for securing approval for exploration drilling.

Exploration Plan
Exploratory well locations, structure maps, and marker formation depths
Analysis of geologic and manmade hazards
Type, sequence, and tentative timing of exploration activities
Geophysical equipment, drilling unit, pollution control devices to be used
New or unusual technology to be employed
Company contact person

Oil Spill Contingency Plan
Response equipment
Responsible agencies/personnel
Response procedures

Environmental Report
Onshore support and storage facilities
Number of people estimated to be employed
Quantity and composition of solid, liquid, and gaseous wastes
Environmentally sensitive areas:

Present use of site	Onsite flora and fauna
Site specific geology	Refuges
Historic weather patterns	Preserves
Physical oceanography	Sanctuaries
Archaeological and cultural resources	Rookeries
Environmental monitoring systems	Calving grounds

Certificate of Coastal Zone Consistency
Certificate for each affected state indicating that proposed exploration activity complies with and will be conducted in a manner consistent with each state's approval Coastal Zone Management program.

Source: U.S. Department of the Interior, Minerals Management Service. 1986. *Managing Oil and Gas Operations on the Outer Continental Shelf.*

The lessee may need to obtain other federal permits from the Coast Guard, EPA, and COE.

Before drilling can begin, the lessee must also have MMS approval on its *Application for Permit to Drill (APD)*, which gives details of the drilling program, including the blowout-prevention system, casing, cementing, and drilling muds. An EPA review is done for the APD. MMS approval may have conditions attached. MMS will continuously monitor drilling operations, revise reserve estimates, and collect revenues.

Affected states concurrently review the Exploration Plan and Environmental Report. They have a maximum of six months to rule on whether the plan is consistent with the state's federally accepted *Coastal Zone Management Plan* (as required by CZMA). (Figure 2.2 illustrates the exploration review process and the timing involved.) State and local authorities will also assume regulatory and permitting authority over the siting and operation of service and supply bases and over operations within state waters. At this point in the process, the state and local governments address issues such as emergency response and begin planning for the potential development phase.

DEVELOPMENT AND PRODUCTION PLAN

Before development and production plans can be implemented, they, too, must be approved. A plan, which may cover one or more leases, describes the work to be performed, facilities to be used, location and depths of proposed wells, geological and geophysical data, safety standards, and a time schedule of activities. The Development and Production Plan is also accompanied by an oil spill contingency plan and an Environmental Report. (MMS does a NEPA review at a minimum for all plans and does an EIS at least once for a new production area or region.) A more extensive shallow hazards survey may also be necessary.

When the plan is complete, MMS begins its technical review and forwards copies to other federal agencies and to the governors, certain state agencies, and certain local governments of affected states. (Figure 2.3 illustrates the production and development review process and the timing involved.) Again, the governor can submit comments to MMS for technical review. At the same time, the state must rule on whether the plan is consistent with the federally approved CZM plan. If the plan is ruled inconsistent, the lessee may modify the plan and resubmit it to MMS for reconsideration, or may appeal to the Secretary of Commerce. In some cases, an Environmental Assessment or EIS is ruled necessary.

During development, just as during exploration, an Application for Permit to Drill must be filed and approved for each well that is drilled, deepened, or plugged back. MMS also approves drilling permits (with conditions attached), approves all OCS pipelines in federal waters, and continues to collect revenues.

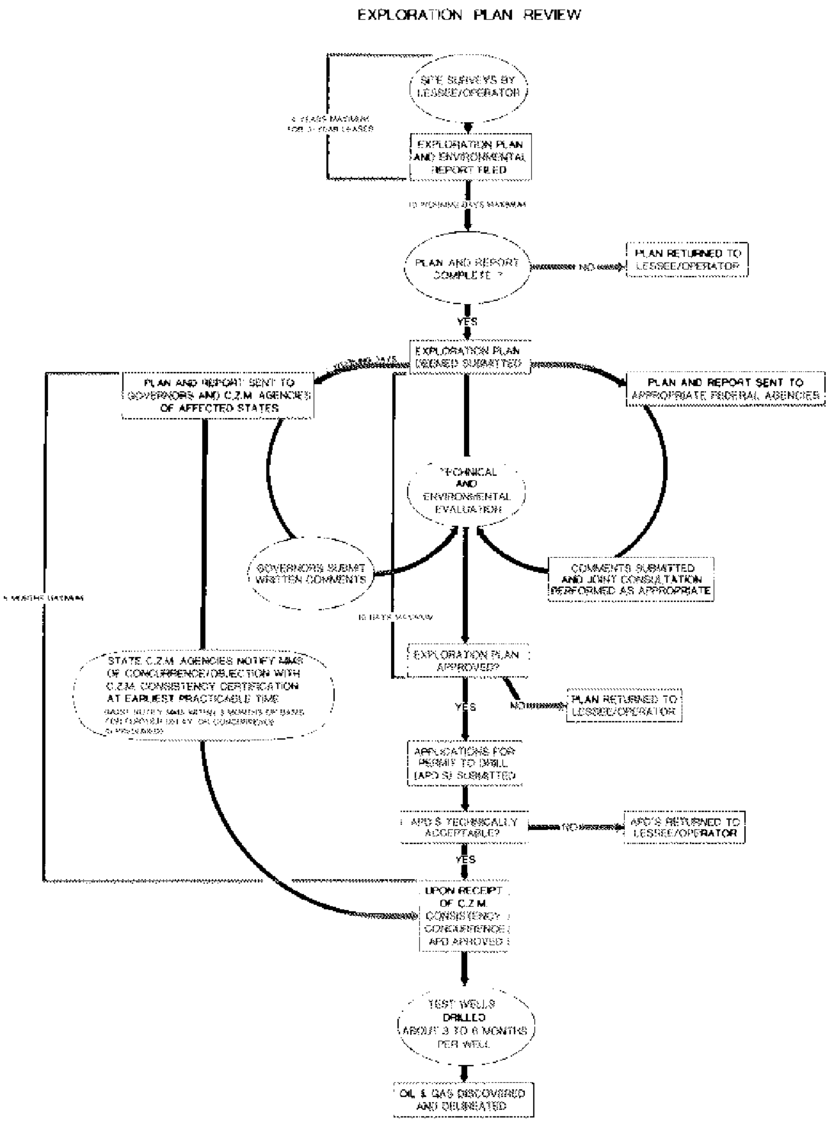


Figure 2.2 Review Process for an Exploration Plan. (Source: Minerals Management Service)

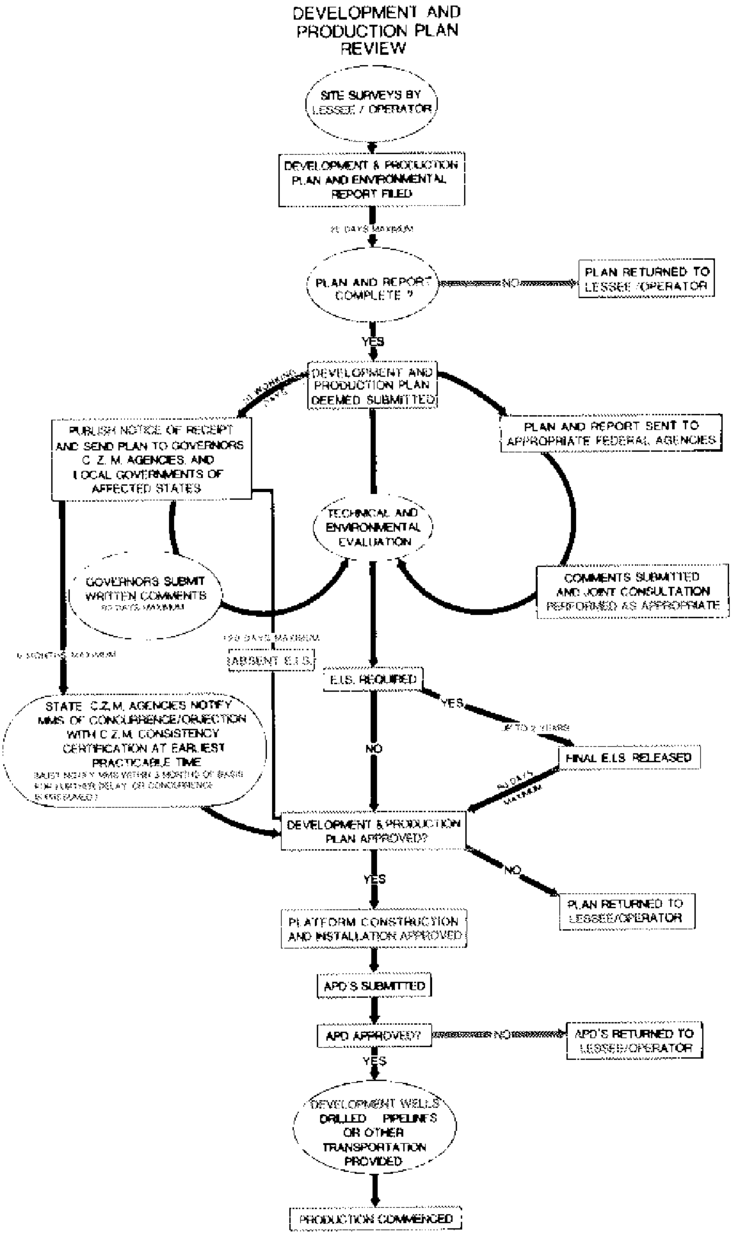


Figure 2.3 Development and Production Plan Review Process. (Source: Minerals Management Service)

During development, the lessee must also obtain other federal permits or approval: the Environmental Protection Agency issues pollution control permits for discharges in state and federal waters and for virtually all major onshore facilities for the production phase; the Corps of Engineers issues permits for platforms in navigable waters; and the Corps of Engineers and the U. S. Coast Guard regulate navigation.

State and local authorities issue permits for nearshore and onshore pipeline rights-of-way, land use, and construction of nearshore and onshore facilities. They will also plan siting of service and supply bases, plan for emergency response, regulate water and other resource uses, regulate hazards to the environment, and provide public services for employees and any population increases. Population impacts reach a temporarily high level for the relatively short development phase.

As the offshore oil and gas industry reaches the production phase, many agencies are involved in monitoring and regulating routine operations and in maintaining readiness for emergencies like oil spills. In addition to MMS, the Corps of Engineers, Coast Guard, Environmental Protection Agency, Occupational Safety and Health Administration (OSHA), Department of Transportation, Interstate Commerce Commission, and others have roles. MMS also continues to revise reserve estimates, collect revenues, and may conduct additional leasing.

State and local activities include providing services for onshore facilities and the added population, monitoring onshore petroleum operations, and planning for and then accommodating the employment decline associated with production and shutdown.

3

The Offshore Oil and Gas Industry

To deal effectively with potential offshore oil and gas development requires an understanding of the oil and gas industry. Industry is the prime "mover" in the process of oil and gas development, and in most cases, other entities will react to the decisions industry makes. The basic functions of the oil industry are:

- *Exploration and Production*—exploring and bringing petroleum to the surface (science and mechanics).
- *Transportation*—delivering crude products to refineries and refined products to markets.
- *Manufacturing*—refining and petrochemical processing.
- *Marketing*—selling wholesale and retail products.

Companies engaged in all aspects of industry operations are called *integrated companies*. Other companies are *semi-integrated*, performing more than one but not all functions. Many more firms have a single function.

The following descriptions concentrate on the methods of operation of major oil companies. These companies are multinational—that is, they are large, vertically integrated companies that operate in a global market through complex organizational structures involving national subsidiaries and affiliates.

The major oil companies frequently contract for many technical and support operations, such as seismic testing, drilling, or operating supply boats. There may be partnerships, contractors, subcontractors, and sub-sub-contractors all working simultaneously on a given oil project, perhaps on a particular oil platform. The experience of other states suggests that the layers of contractors may complicate issues of accountability and responsibility.

Although current oil prices are low, the major companies are generally financially stable and are expressing some interest in the resource potential of areas off Washington's coast. Although some well data and other geologic evidence are available, the hydrocarbon potential of this area is subject to considerable speculation. In the *Proposed 5-Year Outer Continental Shelf Oil and Gas Leasing Program, Mid-1987 to Mid-1992, Final Environmental Impact Statement*, MMS estimated that conditional oil and gas resources in the Washington/Oregon OCS area would be equivalent to about 58 million barrels, requiring one platform, which is significantly

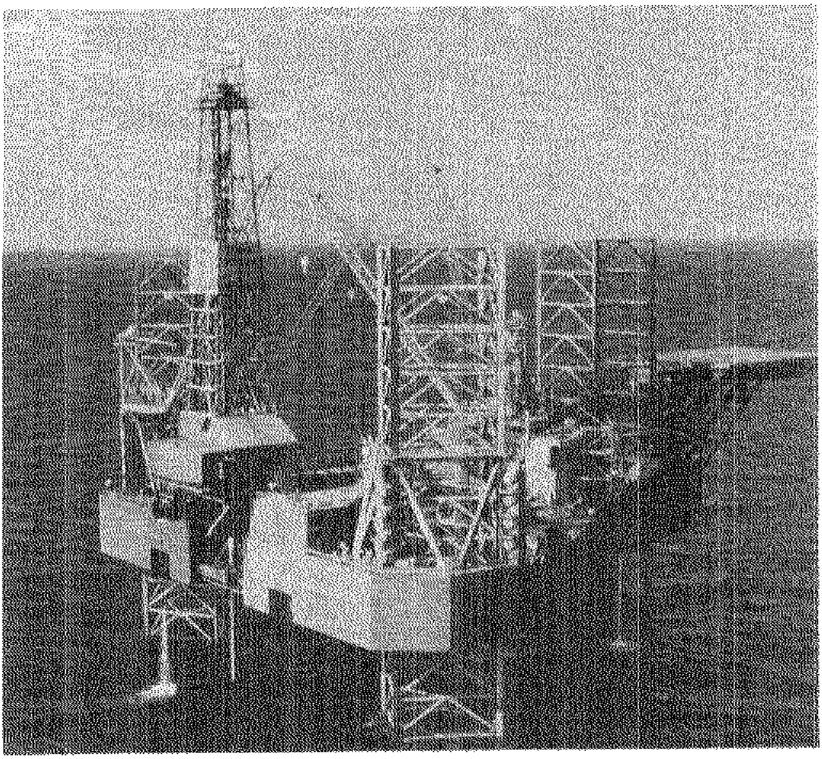


Figure 3.1 Rowan "Gorilla I." This jackup rig, used for exploration drilling, is designed to survive up to 90-foot waves and 82-knot winds in up to 328 feet of water. There are 42,265 square feet of deck area, and the heliport is 83 feet in diameter. Each spud can at the foot of each leg is 66 feet in diameter, and each leg jacks independently at 90 feet per hour. There are accommodations for 80 persons plus a six-man hospital. There are five blowout preventers and four lifeboats with combined capacity for 164 people. To minimize pollution, deck and drill floor liquid wastes are drained and collected in a central sump. (Photo: Rowan Companies)

less than the 413 million barrels and nine platforms estimated for the southern California OCS lease sale area. (Table 3.1 compares estimates of oil and gas resources for several MMS lease sale areas.) Estimates of recoverable resources, however, are continually revised as more geological and geophysical information becomes available. In the Pacific Region, MMS estimates of annual oil and gas reserves steadily increased between 1981 and 1986 (Table 3.2).[1] Occasionally those revisions are dramatic, particularly in areas where geological information is initially limited.

Several industry sources indicate that major companies are apt to show more interest than small independent operators in exploring financially risky areas like the Washington OCS. Independent operators usually limit

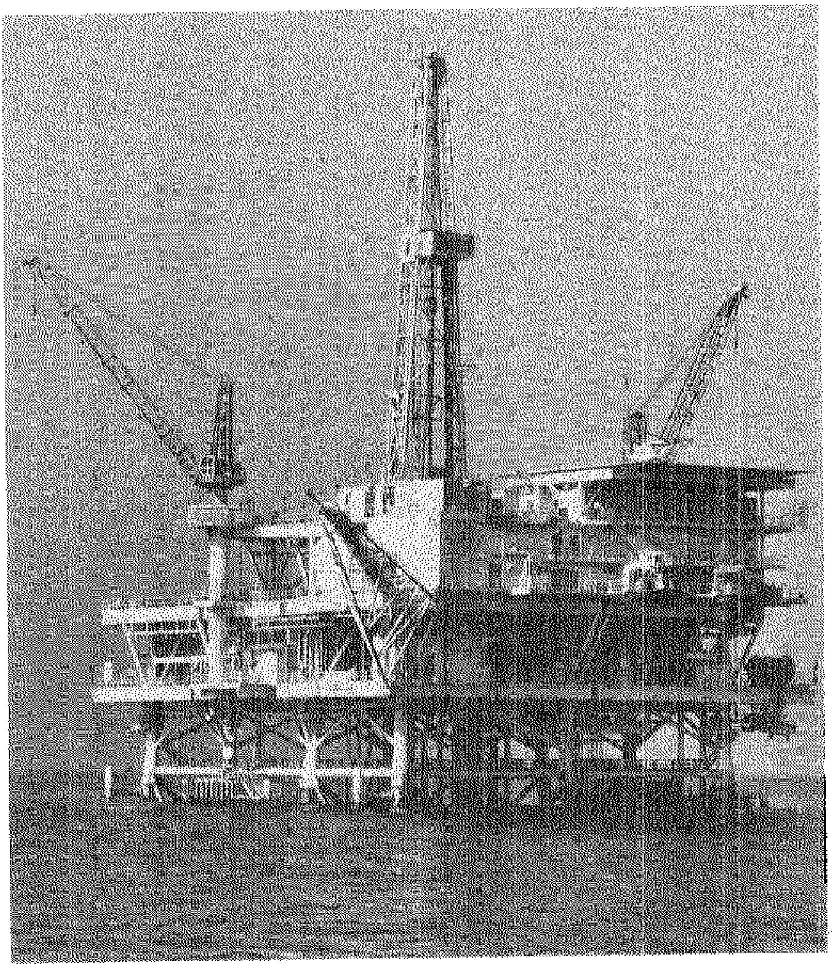


Figure 3.2 Platform Gail. This production platform was installed off Ventura, California in 1988 for $127 million. Up to thirty-six development wells may be drilled at $2 to $5 million each. Primary separation of the oil, gas, and water will occur on the platform, with oil and gas moving by pipeline to Carpenteria and thence to a refinery in Long Beach. (Photo: Chevron, USA)

their risks by restricting their ventures to basins where economic fields have already been found.

Offshore oil and gas resource development is typically described as a five-phase cycle. This chapter first discusses the five phases, noting the activities and decisions at each step, then describes in greater detail several specific industry facilities and activities. Facilities may be offshore, onshore, or part of the transshipment system, which links all the facilities.

Table 3.1 Minerals Management Service estimates of oil and gas resources and expected development for selected lease sale areas.

	Conditional Resources					Projected Number		
Lease Areas	No. Sales	Oil MMBBL[1]	Gas BCF[2]	Million BOE[3]	MPCH[4]	Expl./ Devl. Wells	Devl./ Prod. Wells	Plat-forms
Wash./Or.	1	58	1043	243	0.20	10	29	1
S. Calif.	2	413	627	524	1.00	184	425	9
C. Calif.	1	153	286	204	0.65	10	24	1
N. Calif.	2	231	1023	413	0.60	20	48	2
Gulf Alaska	1	93	1443	350	0.08	11	35	1
Cook Inlet	1	179	298	231	0.03	10	23	1
Beaufort Sea	2	627		627	0.70	22	61	2
W. Gulf Mex.	5	437	6155	1532	1.00	713	912	76
C. Gulf Mex.	5	893	7366	2203	1.00	1113	1428	119
E. Gulf Mex.	2	62	329	120	0.99	19	36	2
S. Atlantic	1	70	1288	299	0.25	11	35	1
Mid-Atlantic	1	50	837	199	1.00	10	23	1
N. Atlantic	2	49	961	220	0.30	18	26	2

1 MMBBL: million barrels
2 Billion cubic feet
3 Barrels of oil equivalent
4 MPCH denotes marginal probability of commerical hydrocarbons.
Source: U.S. Department of Interior, Minerals Management Service, 1986.

PHASES OF OIL AND GAS DEVELOPMENT

Each phase in the development of offshore oil and gas resources—leasing, exploration, development, production, and shutdown—has certain characteristic activities.

LEASING

The leasing phase evolves from the Minerals Management Service (MMS) five-year lease sale process, which is mandated in the OCS Lands Act Amendments (described in Chapter 2). When MMS lists an outer continental shelf (OCS) area on its five-year plan, both MMS and industry prepare for the lease sale; governments of the named areas must at the same time prepare their responses.

Industry's search for offshore oil and gas begins with thorough analysis of an area's geologic characteristics by individual companies. To help determine the OCS lease offerings on which to bid, companies use whatever geologic and geophysical information they can accumulate. They will rely heavily on their interpretations of geophysical (seismic) surveys to

Table 3.2 Minerals Management Service estimates of oil and gas reserves and cumulative production for federal waters in the MMS Pacific OCS Region as revised over 1981-86. (Oil in million barrels; gas in billion cubic feet.)

Federal data	1981	1982	1983	1984	1985	1986
Number of fields	13	14	20	23	24	24
Original Reserves[1]						
Oil[2]	1,082	1,217	1,433	1,515	1,599	1,670
Gas[2]	1,847	1,983	2,298	2,400	2,334	2,461
Annual Production						
Oil	20	29	31	31	30	29
Gas	13	18	24	46	65	59
Cumulative Production						
Oil	221	249	280	310	340	369
Gas	114	132	156	202	267	326
Remaining Reserves[1]						
Oil	861	968	1,153	1,205	1,259	1,302
Gas	1,733	1,851	2,141	2,198	2,067	2,135

1 Changes in reserve estimates from year to year are due, in part, to modifications to the initial estimation.
2 Oil includes crude oil, condensate, and gasplant products sold. Gas includes both associated and nonassociated dry gas.
Source: U.S. Department of Interior, Minerals Management Service, 1986.

identify geologic formations that may contain oil or gas (Figure 3.3).

Formations may be studied more thoroughly if MMS authorizes a group of companies to drill a continental offshore stratigraphic test well (COST well), in which core samples are studied to identify geologic features and strata suitable for oil production. Two COST wells were drilled in California in remote offshore locations, to add to the ample geological information available from the many nearshore wells. While there is limited experience in drilling offshore in Washington, some offshore well data are available to all interested parties. Opinions vary on whether a COST well off Washington will be requested.

EXPLORATION

Companies formulate their bids in MMS's lease sale on the basis of analyses and estimates about an area's potential. When a company (or group of companies) obtains a lease, it begins applying for permits to explore the site.

During the early exploration phase, the company that obtains a lease may conduct lease-specific geophysical surveys and geologic sampling. When needed, cultural and biological surveys are conducted also. The lessee

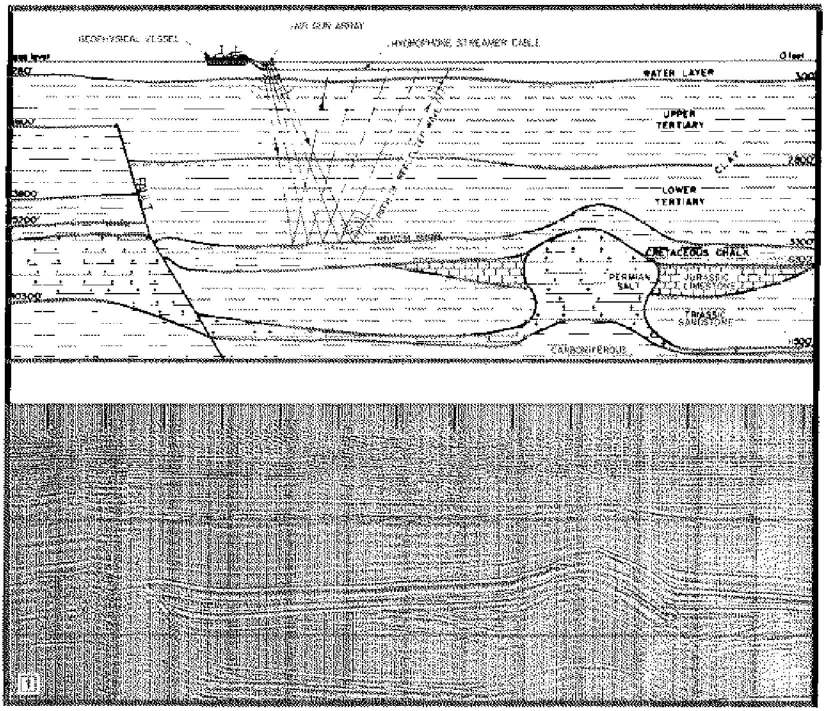


Figure 3.3 Marine Seismic Surveys. These geophysical surveys identify geologic formations that may contain oil or gas. The survey print-out, at bottom, reflects the geologic structures shown in the schematic above. (Source: Geophysical Services)

submits a comprehensive *Exploration Plan and Environmental Report* to MMS for review. (Table 2.2 in the previous chapter lists the reports that must accompany an Exploration Plan.) The company may conduct shallow hazards surveys to determine geologic or man-made hazards on or below the sea floor. Some analyses may be done by divers or remotely operated vehicles.

Once a lessee has received MMS approval on an Application for Permit to Drill and has obtained all permits necessary, it may drill exploratory wells to determine whether oil or gas is present in commercial quantities. Exploratory wells are temporary, not used for any production. If there is a petroleum discovery, additional temporary wells are drilled to identify the extent and characteristics of the find. Federal regulations require complete removal below the mudline of all parts, casing, and materials of the well upon abandonment.

DEVELOPMENT

Once it is decided that a leased site merits commercial development, and after its planning and permitting are complete, production and

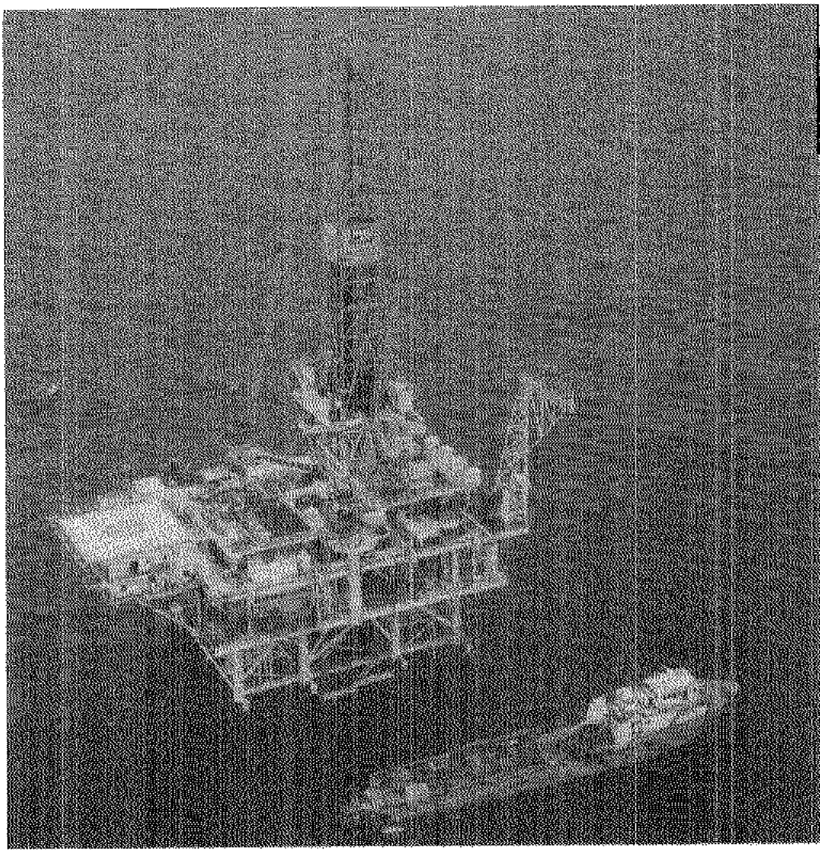


Figure 3.4 Platform Irene. Shown with a supply boat off Pt. Arguello, California. Note helipad and gas flare boom. (Photo: Unocal)

transshipment plans are laid. A stationary platform, designed to remain in place for the life of the field (about 30 years) will be ordered and installed. These platforms will be capable of drilling multiple wells and sustaining crews, equipment, and supplies. A typical California platform may have 30 or more wells, depending on the characteristics of the hydrocarbon resource and the size and characteristics of the field (Figure 3.4). Concurrently, onshore support facilities and transshipment facilities (pipelines, terminals, new tankers or barges) will also be built.

The development phase is a period of intensive growth, temporarily requiring more manpower and support services and creating more impacts than any other phase.

PRODUCTION

When one or more wells are completed and all systems for transshipment and for treatment or processing are operational, production begins.

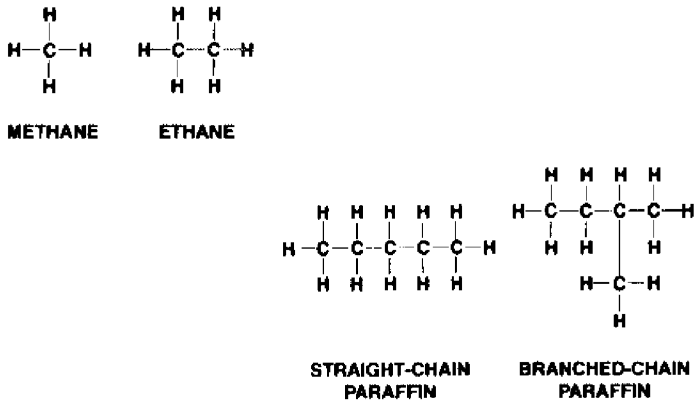


Figure 3.5 Chemical Structures of Hydrocarbons. (Top) All hydrocarbon molecules consist of carbon and hydrogen atoms. The number of atoms and the types of linkages between them determine the type of hydrocarbon, from the lightest gases (methane with one carbon atom, ethane with two) to liquids (5-35 carbon atoms) to solids (more than 35 carbon atoms).

(Bottom) Hydrocarbons can differ even when they are composed of the same the number and type of atoms, because their linkages may differ. Straight-chain and branched-chain paraffins such as these may be found in crude oil. (Source: *Alaskan Update)*

Drilling additional wells usually continues for a period of time after the start of production, in some cases for years.

In general, employment and support activities start to diminish once production begins: fewer workers and less equipment are needed to operate facilities than to build them.

SHUTDOWN

The final phase of the offshore oil and gas life cycle is shutdown, generally 20 or more years after production begins. Since all the hydrocarbons can never be extracted from the subsurface, economics determine when shutdown occurs. When production from a site is no longer profitable, even when using special techniques to augment recovery, industry will stop production.

The company's early plans must include its intent for shutdown. Unless designated as an artificial reef, offshore facilities are required by law to be removed. The well casing typically is cut off at least 15 feet below the mudline and is sealed with concrete. Pipelines are usually left in place. Onshore facilities may be shut down, dismantled, or converted to another use.

INDUSTRY ACTIVITIES AND FACILITIES

EXPLORATION

Most exploration activities occur offshore, where industry surveys the lease site and assesses whether there is economic justification for developing the site.

Offshore Activities

Geological overview. The object of this quest--the black gold that prompts such interest and expense--is *petroleum*, a complex mixture of substances that is primarily hydrocarbons. Hydrocarbon molecules, built from only two elements, carbon and hydrogen, may exist as gases, liquids (oil), and solids (Figure 3.5). At room temperature, the smaller, light-weight molecules such as methane, with only one carbon atom, exist as a gas. Hydrocarbon molecules with from 5 to 35 carbon atoms exist as liquids. Hydrocarbons with 36 or more carbon atoms exist as solids, such as asphalt, tar, and residuum. Crude oil consists mainly of liquid hydrocarbons but is often mixed with some gaseous and solid hydrocarbons (Table 3.3).

The formation of oil and gas in commercial quantities requires relatively long geologic times and some very specific conditions. First, the *source rock*, a sedimentary rock containing dead organisms, has to be "cooked" at the right temperature and pressure for thousands to millions of years to transform the organic matter into petroleum. Then the petroleum has to migrate from the source rock into a porous *reservoir rock* that can hold quantities of petroleum (Figure 3.6). Above the reservoir rock, a *trap rock* must form a seal to prevent the petroleum from rising to the earth's surface and escaping (*natural seeps*).

The search for oil and gas. When petroleum geologists and geophysicists look for oil and gas, they look for structures that could contain petroleum reservoirs: traps, reservoir rocks, and source rocks. Geologists study subsurface well data, analyze core samples, and compare sedimentary systems, structural forms, and faults to examples from

Table 3.3 Composition of a typical crude oil.

Type of hydrocarbon	Carbon atoms in molecule	Percentage of weight
Hydrocarbon gases	1—4	<1
Gasoline	4—10	31
Kerosene	11—12	10
Gas oil/diesel oil	13—20	15
Lubricating oil	20—40	20
Residuum	40+	23
Non-hydrocarbon materials		<1

Source: *Alaskan Update*

hydrocarbon-producing areas elsewhere. Geophysicists study *seismic reflection data* to try to understand the layers and structural forms of the offshore substrate. Verifying the presence of commercial oil and gas, however, requires drilling.

Geophysical surveys and vessels. Geophysical survey (seismic reflection) data, which provide the most detailed information that can be gathered about the offshore substrate without drilling, are collected by a seismic vessel that contracts with an oil company. Seismic vessels are equipped with an acoustic energy source such as a compressed-air gun or a high voltage sparker (Figure 3.7) and sensitive receivers that record the reflected sound waves (Figure 3.8). Although primacord explosives were used occasionally in state-controlled, shallow water areas in Alaska, MMS has not issued permits for geophysical surveys using these explosive devices for several years.

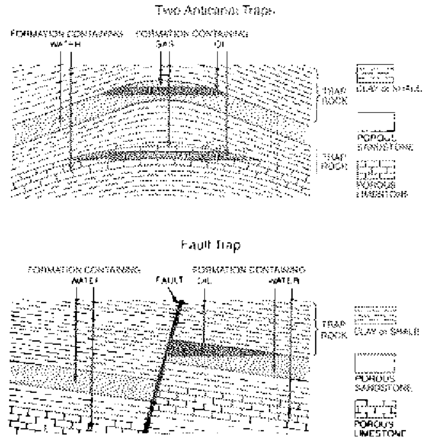


Figure 3.6 Geologic Traps. The two most common kinds of geological formations that trap petroleum into reservoirs: an *anticlinal trap*, where the nonporous trap rock is shaped like an inverted bowl, and a *fault trap*, where a fault or break in the rocks occurred. (Source: *Alaskan Update*)

As a seismic boat traverses the area being explored, it fires the airguns, releasing an *acoustic pulse* that travels through the water and seabed. The acoustic waves reflect off the various structural layers or *strata* beneath the sea floor. These reflections are recorded by the receivers, which are on *streamers* that trail up to about 2 miles behind the boat (Figure 3.9). The data collected are analyzed by computer, producing tracings that represent the structural layers.

To increase the resolution and reliability of images, more comprehensive seismic information is collected, perhaps using a duo boat technique, which requires two parallel seismic vessels operating simultaneously, or a 3-D technique, which requires very close line spacing, with the

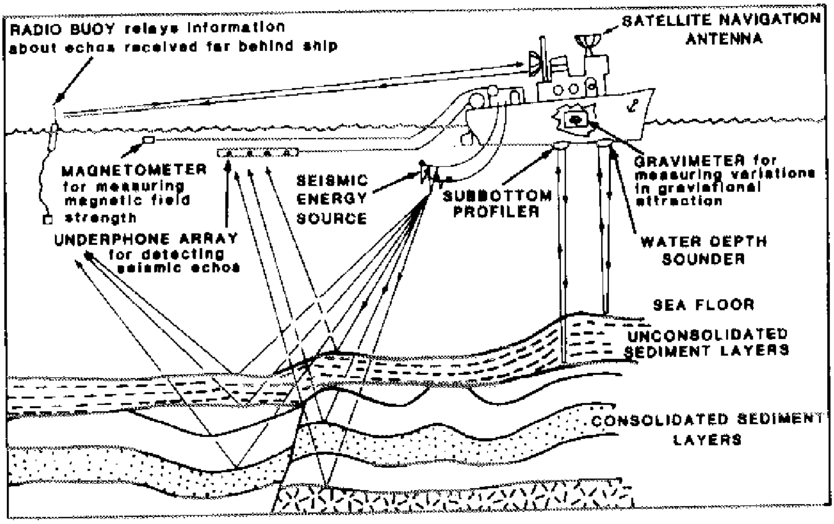


Figure 3.7 Seismic Survey Methods. (Source: Minerals Management Service)

boat traversing about every 50 meters.

Good seismic information can indicate geologic structures that may be traps; however, seismic data do not identify the composition of each layer or its depth. To become truly useful, the information must be correlated with known geology.

Exploratory wells. Regardless of the amount of geological and geophysical data collected, the only way to be certain a site contains oil or gas is to drill. After the leasing company's Exploration Plan and Application for Permit to Drill are accepted by MMS, the company generally contracts with a drilling company for the services of an exploratory drilling rig. Exploratory wells are temporary holes designed for testing and sampling, not for producing. They are drilled in locations deemed promising by available geologic and seismic information.

There are six types of mobile exploratory drilling rigs (Figure 3.10). Some are self-powered; some are towed. Rigs such as jackup rigs, submersibles, and arctic units are designed to rest on the seafloor while drilling; floating drill rigs such as semisubmersibles, drillships, and drill barges can work in deeper water (Figures 3.11 and 3.12). (Drilling processes, including safety mechanisms, are described in greater detail later in this chapter, under "Development and Production".)

As the well is drilled, samples from the hole—rock cuttings and muds—are tested for evidence of hydrocarbons from the formations penetrated. Rock cores cut with special equipment may also be examined. Gas or oil found by these tests is called a *show*. If there is a show, the characteristics of the reservoir rock are further examined to assess how much petroleum it would hold and how available the resource would be. When

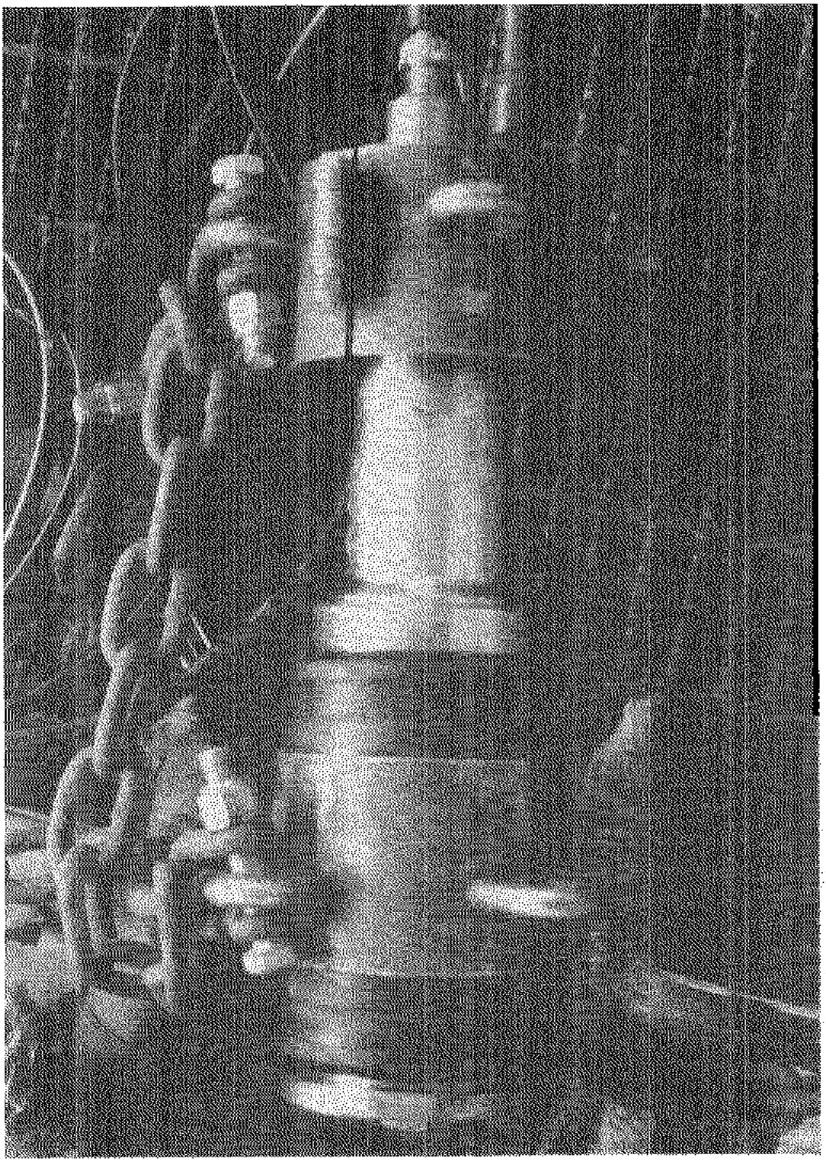


Figure 3.8 Compressed-Air Gun for Seismic Testing. (Photo: Geophysical Services)

drilling stops, tests in the open hole, such as *wireline tests* that measure variations in conductivity, help detect the presence and quantity of petroleum. If oil or gas is found, more exploratory wells are drilled until the field is delineated. A wellhole might produce only gas, only oil, or both gas and oil.

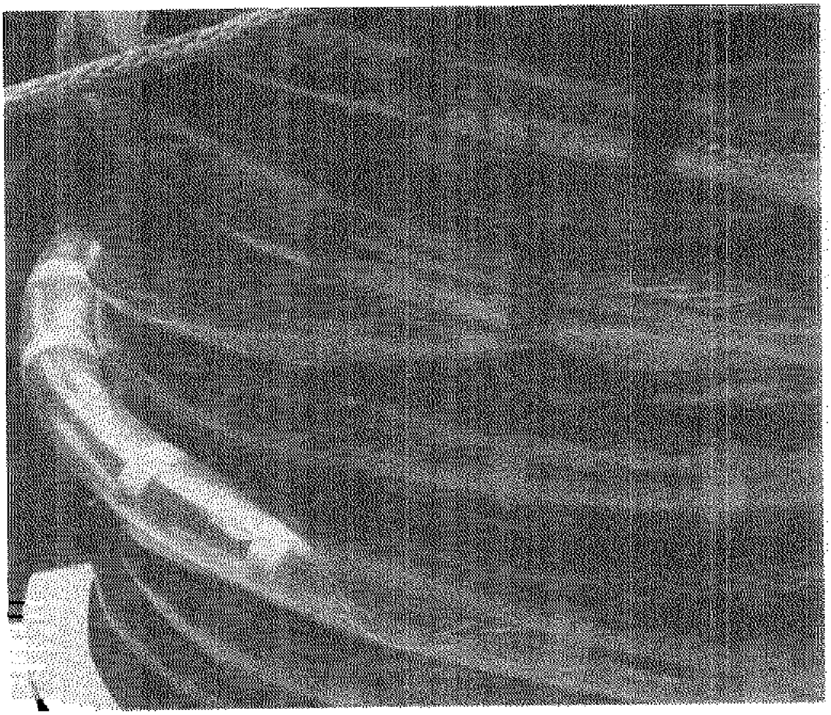


Figure 3.9 Coiled Seismic Streamer Used in Geophysical Surveys. These long cables contain arrays of receiving devices and are towed behind survey vessels to detect "echos" of seismic waves bouncing off the seafloor and subsurface rock layers. Depending on their complexity, the streamers range in cost from $2 to $10 million. (Photo: Carolyn Pendle, ORAP)

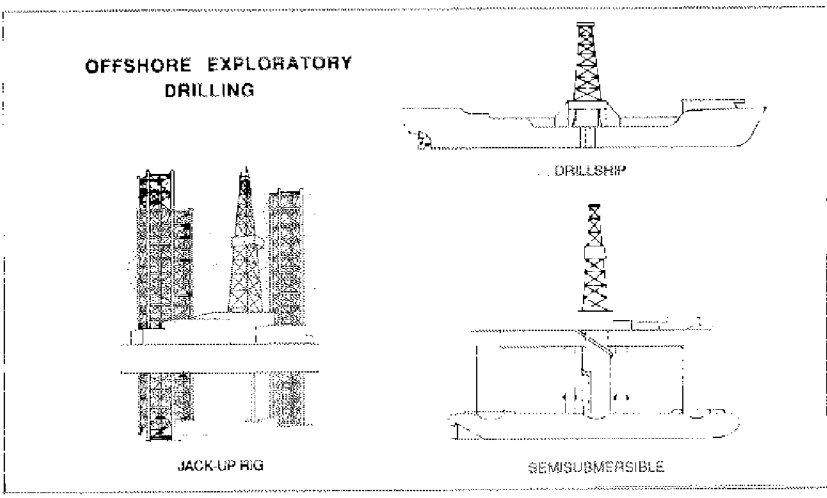


Figure 3.10 Exploratory Drilling Rigs. The most common of the six types are semisubmersibles, jackups, and drillships. (Source: *Alaskan Update*)

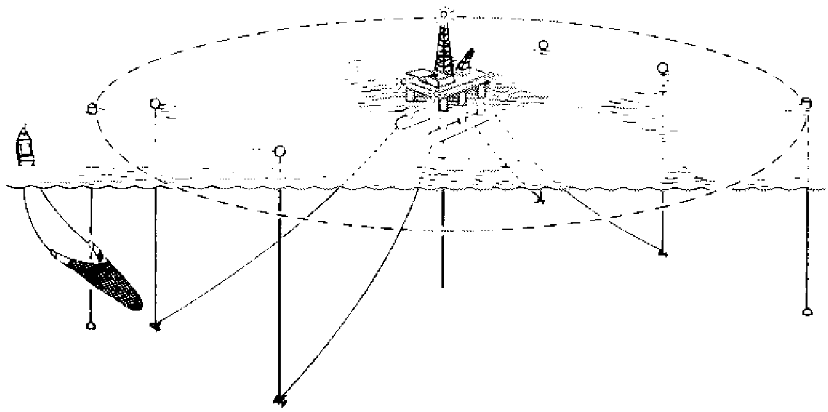
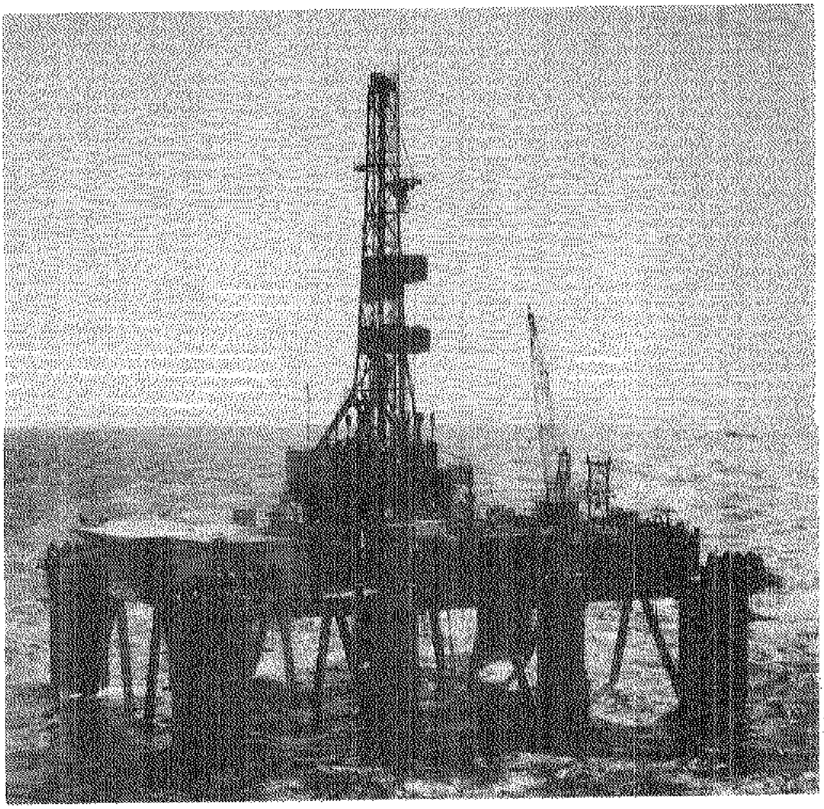


Figure 3.11 Safety Zone Around Rigs. Long anchor lines may be necessary to secure a floating mobile exploration drilling rig. A safety zone of several hundred yards around these rigs may be established by the Coast Guard. Temporarily (2-3 months), boat traffic, including fishing vessels, may be required to stay at least one mile from the rig. (Source: *Questions and Answers About Fish and Offshore Oil Development,* American Petroleum Institute)

Testing also must determine the characteristics of the petroleum, since those characteristics affect how easily the resource can be recovered and how much treatment it requires. The commodity emerging from the well is usually a complex mixture of oil, gas, water, and possibly sediments, which must be separated, treated, and sent to processing or disposal.

The crude oil itself is an assortment of hydrocarbons whose proportions determine the particular character and type of oil. Crude oils may range from almost colorless to brown, green, or pitch black. Some may flow easily; others barely ooze. They vary in specific gravity, which is actually measured in terms of *API gravity*:

> The specific gravity of a liquid is the ratio of its density to the density of water at a specified temperature and pressure. The gravity of oil, which is usually lighter than water, is normally specified not as a fraction of water density but in terms of degrees on the API gravity scale, which allows finer distinctions to be made among oils than measurements in terms of specific gravity. On the API gravity scale, oil with the lowest specific gravity has the highest API gravity. Other things being equal, the higher the API gravity, the lighter (less viscous) the oil, the less complex the refining process. Most crude oils range from 27 degrees to 35 degrees API gravity. (H. R. Williams and C. J. Meyers, *Oil and Gas Terms: Annotated Manual of Legal, Engineering, and Tax Words and Phrases,* 4th ed., Matthew Bender and Co., New York, 1976).



The API gravity is an indicator of end use. The heaviest oils are used to make products like asphalt (API gravity 11 degrees), while the lightest oils may be used for aircraft fuel or gasoline (API gravity 36 degrees). Crude oil in the midrange is used to manufacture many products such as home heating oil, fertilizers, pharmaceuticals, synthetic fabrics, and plastics (API gravity 25 degrees).[2]

Depending on the hydrocarbons they contain, crude oils are classified as *paraffin base*, *asphalt base*, and *mixed base*. Crudes that contain over one percent sulfur and other mineral impurities are called ***high-sulfur crudes***, or at times, ***sour crudes***. Crudes having a sulfur content below one percent are called *sweet*.

Furthermore, gas may be *dry* or *wet*. Wet gas requires additional treatment to remove liquids and condensable water vapors as well as hydrocarbon vapors. Gas containing hydrogen sulfide (*sour gas*) must be treated or "sweetened." Sour gas is odorous and can be highly poisonous.

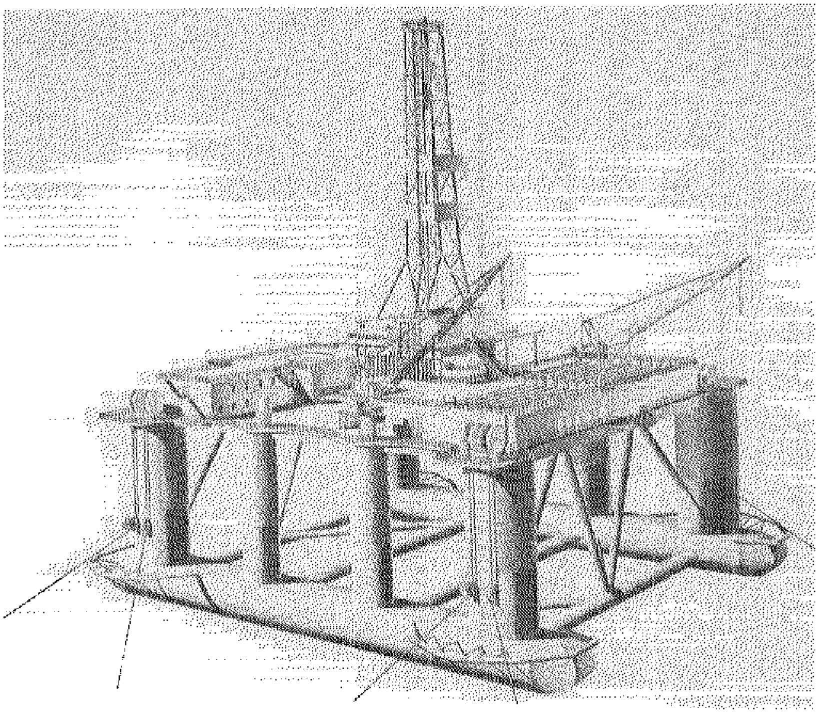


Figure 3.12 Semisubmersible. (Left and above) The *Rowan Midland*, a two-pontoon semisubmersible, is rated for 25,000-foot drilling depths in up to 600 feet of water. Its survival sea state is 86 feet. The two lower hulls are 279 feet long. Crew quarters accommodate 94, plus a six-man hospital. The anchoring system consists of 8 separate moorings, each including a 6000-foot anchor line (2 1/2" wire rope), a 30,000-pound anchor, and an anchor buoy. (Source: Rowan Companies)

Onshore and Transshipment

Activities during the exploration phase require little onshore construction and no shipment of product. Temporary service bases are needed to support the offshore exploratory activities. Industry contracts with boat or helicopter groups to provide supplies and support. At this stage, the contractors usually make use of existing port and airport/heliport space.

Evaluation and Planning

Should petroleum be found, the lease holder examines the available information and evaluates whether the product can be produced at a profit (Table 3.4). If the find is commercially feasible, the company begins detailed planning for production. Production structures are ordered, with the specific design dependent upon:

Table 3.4 Issues that drive industry decisions to develop oil and gas.

Field/reservoir characteristics	Technological issues	Environmental issues	Operational and logistical issues	Sociological and regulatory issues	Economic issues
Number and depth of pay zones	Prior experience with technologies	Wind	Proximity to existing offshore facilities	Proximity to population centers	Market price for oil and gas (Current and 30-year projection)
Trap mechanism(s)	Current limits on technical capabilities	Waves and currents	Distance from shore	Nature and extent of current offshore activity	Prevailing interest rates
Permeability and porosity	Availability of equipment and facilities	Storm magnitude and frequency	Proximity to shore support and terminal facilities	Proximity of cultural & recreational sites	Tax rates and incentives
Competency of substrata		Seismic activity	Availability of harbors	Visual impacts	Initial facility cost
Estimated total recoverable reserves		Competency and stability of seafloor	Availability of utilities	Availability of manpower and housing	Estimated costs of materials for 30 years with projections for inflation
Reservoir temperature and pressures		Sensitivity of marine and shore lifeforms	Production treatment and storage	Regulatory requirements	
Drive mechanisms		Air and water quality	Proximity to existing waterways and shipping lanes		
Water depths			Availability of pipelines		
Hydrocarbon type and composition					
Sea bottom topography					

Source: Clovis Lowe, Jr., Operations Manager, Western District, ARCO Oil & Gas Co., March, 1988.

- characteristics of the field (depth, size, pressure, etc.)
- environment (water depth, weather, oceanographic environment, sea floor slope, hazards, availability of power, etc.)
- the production intent (market conditions, long range plans, etc.)
- government regulations (permitting, air quality regulations, etc.)
- availability and expertise (existing contract commitments, rig availability, contractor experience, insurance approval, etc.).

The lessee also must decide how to treat and transport the oil or gas.

DEVELOPMENT AND PRODUCTION

When construction begins, industry enters the development phase; when the oil or gas starts to flow, industry enters the production phase. During the development phase the facilities are designed and built; during production they are operated. Since, for the most part the facilities are identical and only the activities differ, this discussion of facilities and activities addresses both development and production phases.

Any production system is permanent, designed to be left in place for as long as the wells produce oil or gas profitably. Offshore production structures may stand on fixed legs or may float. They may be completely underwater (subsea completions) or may be built on artificial islands (an option in shallow water only). In deeper water (100 to 1000 feet), various types of platforms have been the most common production structures.

Platforms must be large enough and include facilities to support fully the drilling process, production, transportation systems, and crew (Figure 3.13). For drilling, equipment must include drilling fluid systems

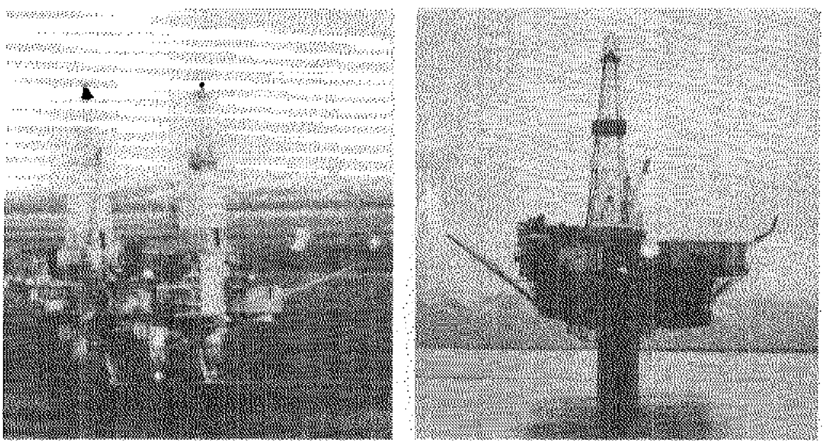


Figure 3.13 Platforms in Cook Inlet. Platform Grayling, a double derrick platform, and the Monopod, both near Kenai, Alaska, illustrate diverse ways platforms meet the needs of production amidst ice and strong currents. (Photos: Unocal)

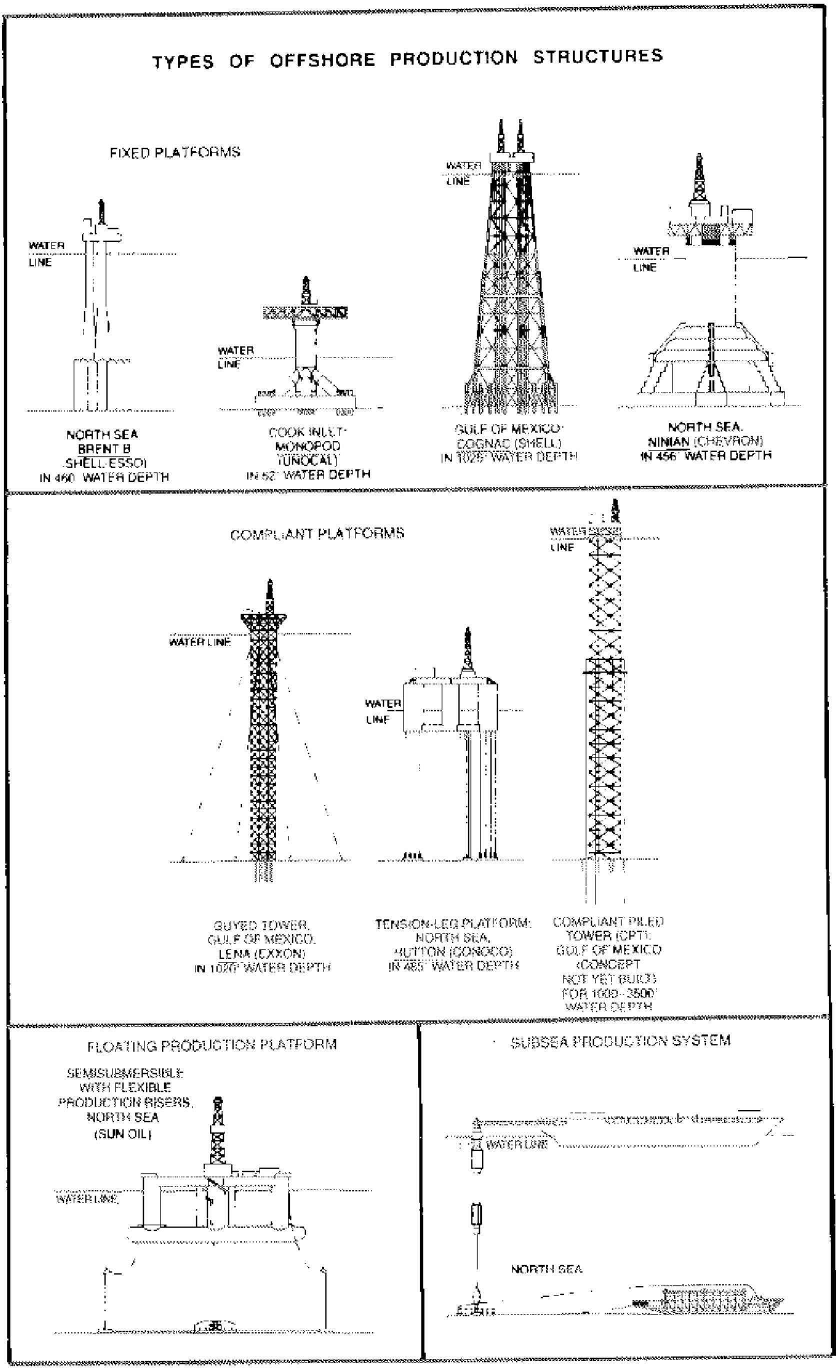

TYPES OF OFFSHORE PRODUCTION STRUCTURES
FIXED PLATFORMS
WATER LINE
NORTH SEA
BRENT B
(SHELL/ESSO)
IN 460' WATER DEPTH
COOK INLET
MONOPOD
(UNOCAL)
IN 52' WATER DEPTH
GULF OF MEXICO
COGNAC (SHELL)
IN 1025' WATER DEPTH
NORTH SEA
NINIAN (CHEVRON)
IN 456' WATER DEPTH
COMPLIANT PLATFORMS
GUYED TOWER,
GULF OF MEXICO,
LENA (EXXON)
IN 1000' WATER DEPTH
TENSION-LEG PLATFORM:
NORTH SEA,
HUTTON (CONOCO)
IN 485' WATER DEPTH
COMPLIANT PILED
TOWER (CPT):
GULF OF MEXICO
(CONCEPT
NOT YET BUILT)
FOR 1000-3500'
WATER DEPTH
FLOATING PRODUCTION PLATFORM
SEMISUBMERSIBLE
WITH FLEXIBLE
PRODUCTION RISERS,
NORTH SEA
(SUN OIL)
SUBSEA PRODUCTION SYSTEM
NORTH SEA

Figure 3.14 Selected Types of Offshore Production Platforms. (Left) Fixed, compliant, subsea, and floating systems are among the technological choices available for production. (Source: *Alaskan Update*)

and pipe handling and storage. For production, platforms must include at least minimal separation and treatment facilities, equipment for handling wastes and produced water, safety equipment, and possibly some storage ability. Platforms must connect with transportation systems for oil and gas (if both are present). In order to transport people and supplies, platforms have a helipad and a dock. Platforms must also provide comfortable accommodations for crew members, who generally live on the rig for a week or more at a time.[3]

Offshore

Types of production systems—platforms and subsea completion. The decision to install a platform or subsea system depends on the characteristics of the reservoir (size, shape, and type), depth of the water, sea conditions, distance from land and from other facilities and pipelines. For deepwater production, platforms may be either fixed leg or compliant (Figure 3.14). Both fixed leg and compliant platforms are able to fully support well drilling, completion, production, and maintenance, and to provide some treatment of the product and connections to a transportation system.

Fixed leg platforms are massive steel structures, with legs implanted in the seabed and extending up to a safe height above the water. (Monopods, which perch on a single, trunk-like leg, exemplify platform variations.) The platform itself may rise 170 feet above the ocean surface, with three deck levels and many separate rooms. Platforms are designed to minimize the danger of damage from accidents or forces of nature, from storms to earthquakes. Many oil and gas wells can be drilled from the platform (generally less than 60), with wells reaching perhaps 10,000 feet below the ocean floor. Directional drilling allows individual wells to be deviated from vertical to reach much of the oil field surrounding the platform. The site of the platform is chosen to maximize ultimate production, but other factors play a part, including reservoir characteristics, water depth, sea floor engineering constraints, and platform-design economics. Sometimes several platforms are needed to develop a particular field.

The deeper the water, the more steel required for platform construction, and the more difficult platform fabrication and installation becomes. In deeper water, production structures other than platforms become more economical. *Compliant structures* do not depend upon brute strength; they give or move somewhat in response to wind and waves, tolerating considerable lateral motion but very little vertical motion on the production deck.

Of the varieties of compliant structures, *guyed towers* may be useful in water up to 2,000 feet deep. They are tall, slender platforms held in place vertically by guy lines that extend to the sea floor. *Tension leg platforms* are floating platforms rather like semisubmersible drilling rigs. Vertical tension members hold the platform to the sea floor, making it stable enough to operate production systems. Engineers say this type of platform could function in water depths up to 10,000 feet. Conoco Inc. has reported a new concept for a single leg, tension leg platform that reduces the number of moorings, the movement (heave) of the platform, and the foundation costs.

Over the past 20 years, *subsea production systems* have been used in several offshore areas around the world. Subsea system wells must be drilled from a floating rig. Each well is completed on the sea floor, equipped with blowout preventers, and attached to flow lines that carry the commodity to a platform production facility, where it is treated and transported. The system may also have a *manifold* that collects the oil and gas from several wells before the flow lines carry them to the surface.

Drilling techniques and equipment. The processes for drilling production wells are similar even though wells vary greatly in depth and in types of rock formations they penetrate. Any oil and gas drilling operation requires several basic systems:

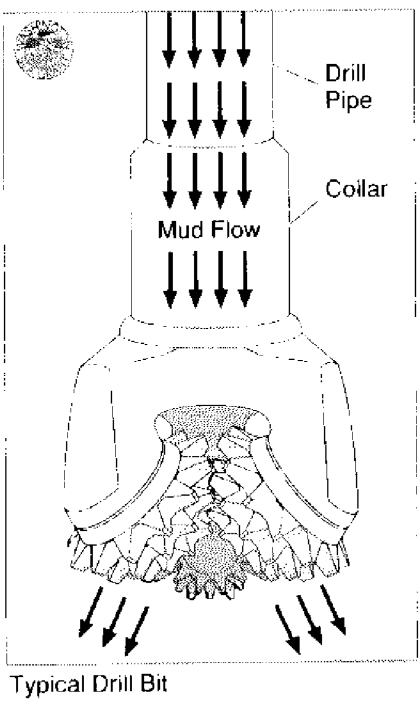


Figure 3.15 Mud Flow Through Drill Bit. As a drilling bit is rotated, the teeth break up rock. Mud flows through the bit and carries rock cuttings to the surface.

- rotary drilling
- hoisting and pipe-handling
- drilling fluid
- well control
- power

Rotary drilling equipment. The basic rotary drilling equipment provides a fairly simple technique for drilling wells. Rotating the *drilling bit* with downward pressure forces the rough teeth of the bit to break up the substrate rock (Figure 3.15). What complicates the system is the need to drill at great depths, through various kinds of rock, at unknown underground pressures.

To allow the drilling bit to extend deeper and deeper into the substrate, the bit is attached to lengths of *drill pipe*, which can be screwed together. Each *joint* is about 30 feet long. The upper portions of the *drill string*, as the entire assembly is called, include essential parts that allow the string to rotate. The entire drill string has passageways through which drilling fluids pass (Figure 3.16).

Hoisting and pipe-handling system. The hoisting and pipe-handling system supports the rotary drilling equipment in the hole and moves the drill pipes. Each time the drill bit needs replacing, whether for maintenance or for new rock types, the entire drilling assembly (bit and complete drill string) must be lifted out of the hole. Also, to enable drilling to go deeper, a new joint must be added to the string each time the bit drills the length of a joint. Usually joints are added or subtracted three at a time, with the three-joint-unit called a *stand*. These activities require special equipment to lift, move, and store drill pipe: a tower-like *derrick* stands over the hole; *drilling lines* can lift and move the pipes and equipment; *racks* store the pipe.

Drilling fluid system. The drilling fluid system has three main functions: it must (1) carry rock cuttings to the surface and (2) maintain pressure in the hole to prevent water, oil, or gas in rock formations from entering the hole, and (3) lubricate and cool the drill bit. The system includes the fluid itself—*drilling mud*—as well as equipment to circulate the mud. Mud mixtures are designed specifically for each hole, but the main ingredients are water (fresh or seawater), clay, and weighting materials such as barite. Other ingredients may be added to make the mud heavier or lighter, cooler or warmer, to provide more lubrication, or to form a thin cake on the sides of the well. While oil-based drilling fluids may be used elsewhere, EPA regulations do not allow them to be dumped in U.S. waters, where their use is rare.

Drilling mud is mixed in *mud pits*, then pumped through a hose and down through the drill string and the bit (Figure 3.17). From there the pumping pressure forces the mud upwards through the annular space between the drill string and the wall of the hole. As the mud rises, it carries the *rock cuttings* to the top of the hole and back to the mud pits. *Shakers* and cleaning equipment remove the cuttings, silt, and sand from the mud.

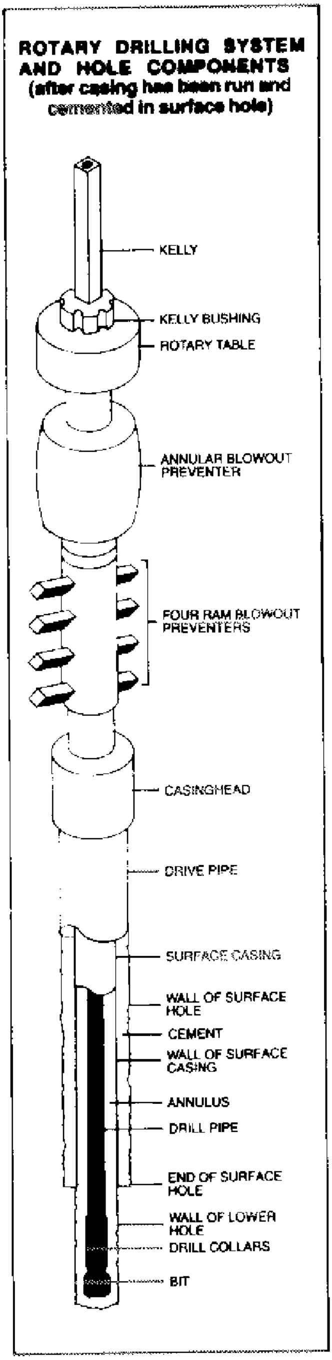


Figure 3.16 Rotary Drilling System and Hole Components. This illustrates how to drill an oil well. (Source: *Alaskan Update*)

The mud is monitored and continually recirculated. Additives to the mud pit can adjust for new situations encountered. The drilling mud is the first defense against *blowouts*, explosive accidents typically caused by sudden changes in formation pressure.

Federal regulations control the disposal of muds and cuttings from an offshore rig or platform. Depending on the ingredients, mud may be discharged into the sea; it is commonly released from a platform somewhere below sea level. Otherwise, muds and cuttings will be stored and transported to approved disposal sites.

Well-control. The well-control system includes equipment to maintain control of formation pressures and prevent blowouts (described later in the chapter, under "Preparation for Emergencies"). Besides the drilling fluid system, there are two kinds of *blowout preventers*—ram type and annular—stacked at the top of the hole, as well as another series of valves at the well surface, called a *choke manifold*. Blowout preventers have valves that can manually or automatically close to seal off the flow from the well hole. Annular blowout preventers close off wells by squeezing rubber packing units tightly around whatever is in the hole (drill shaft, kelly, etc.) (Figure 3.18). Ram-type blowout preventers work by moving two opposing semi-circular rams toward each other, thus completely surrounding the pipe and sealing off the annular space around it. Ram BOPs fit only the size pipe for which they are designed. Blind rams are flat and can close off a well hole with no drill pipe in it. Shear rams are sharp and can actually cut

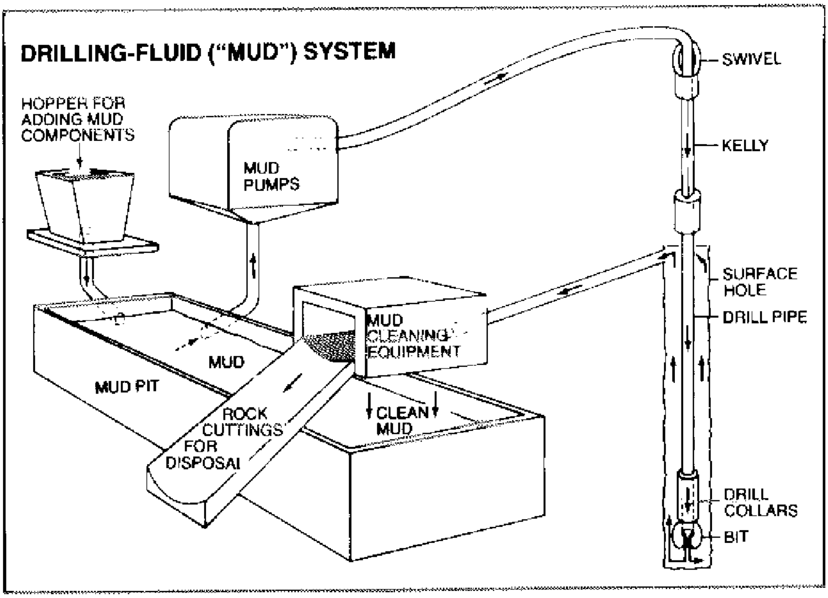
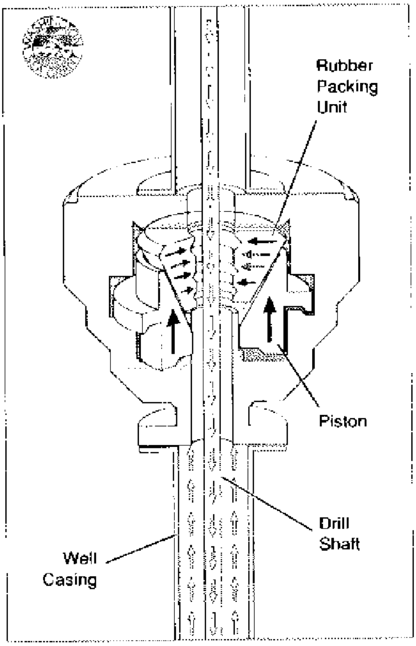


Figure 3.17 Drilling-fluid (Mud) System. The characteristics of the mud can be changed as it is recycled through the hole. (Source: *Alaskan Update*)



Annular Blowout Preventer
(Cutaway view)

Figure 3.18 Annular Blowout Preventer. Mud flows down the drill pipe and returns up the annulus around it. When activated, this BOP squeezes down around the pipe, stopping the return (upward) flow. It is part of the BOP stack (see Figure 3.16).

through the drill pipe to stop a blowout in an emergency (Figure 3.19).

During production, *Christmas trees* (so-called because their extended valves and guages look like decorated branches) control the rate of flow of oil and gas from the well. Drilling rigs or production platforms also have *flare booms* (see box) to burn off natural gas that is not recoverable.

The well-control system is important both for preventing accidents and for controlling flow rates during production. If the production rate is

***Gas Flaring** is wasteful but sometimes necessary for safety and environmental protection. Gas from an offshore well is normally either re-injected into the field or separated from oil and water, compressed, and pumped ashore via pipeline. But what if the compressors malfunction or fail? Gas flares relieve and safely dispose of any hydrocarbon vapors (waste gas) from drilling, production, or pipeline operations through virtually complete, smokeless combustion. The flare is installed on an angled boom extending away from the offshore platform to reduce thermal radiation and prevent liquid carry-over or "burning rain" in high winds. Noise and visibility (both smoke and light) can be of aesthetic and environmental concern. Free-floating satellite flares may be used for deep-sea drilling rigs, and anchored satellites are available for shallow-water applications.*

Ram Type Blowout Preventer

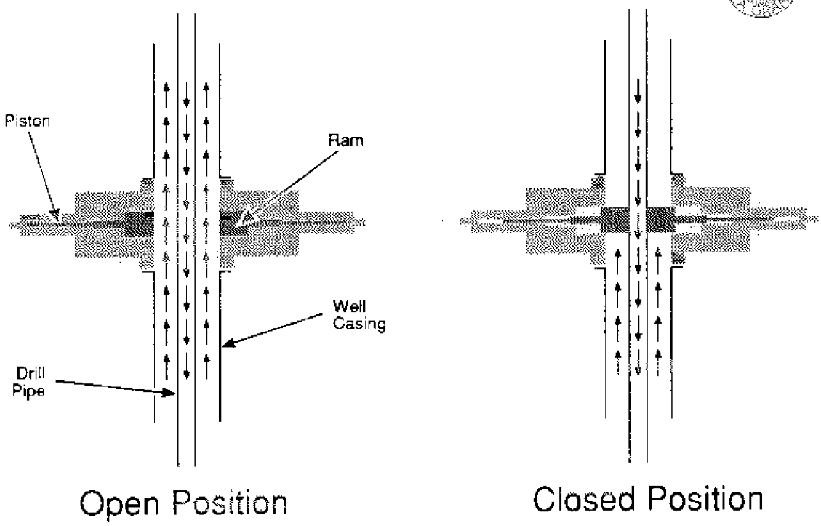


Figure 3.19 Ram Blowout Preventers. One type of ram blowout preventer stops the flow up the annulus by closing its two opposing parts against the drill pipe, as shown. The two opposing parts of the blind ram BOP (not shown) are flat and close against each other when there is no pipe in the hole. The shear ram BOP (not shown) cuts through the drill pipe and stops upward flow in both the annulus and the pipe. The BOP stack (see Figure 3.16) may contain one of each ram type to cover all contigencies.

too fast, pressure may drop in the production formation, decreasing the amount of petroleum that is ultimately recoverable.

Power. The power system that drives the drilling of an oil or gas well may be either a diesel internal combustion engine or electric motors. Production platforms require an ample supply of power.

Drilling Procedures. The drilling of a typical hole is done in stages. For offshore development operations, the first hole drilled may be 24 inches in diameter and may be drilled to over 1000 feet below the sea floor. This hole is lined with conductor casing and cemented. A *surface hole*, which may range from a few hundred feet to several thousand feet in depth, might have a hole diameter of almost 18 inches. After the surface hole is drilled, the entire drill string is pulled out (*tripped out*), three joints at a time, so that the hole can be lined with hollow metal pipe called *casing*, which is cemented in place (Figure 3.20). The cement fills the space between the rock and the casing. Casing keeps the hole from caving in and prevents formation gases and fluids from leaking into the hole. Next the drill string, with a smaller diameter bit, is put back in the hole to drill an *intermediate hole* that is approximately 12 inches in diameter. The bit goes deeper and deeper as new joints of drill pipe are added. Again the drill string

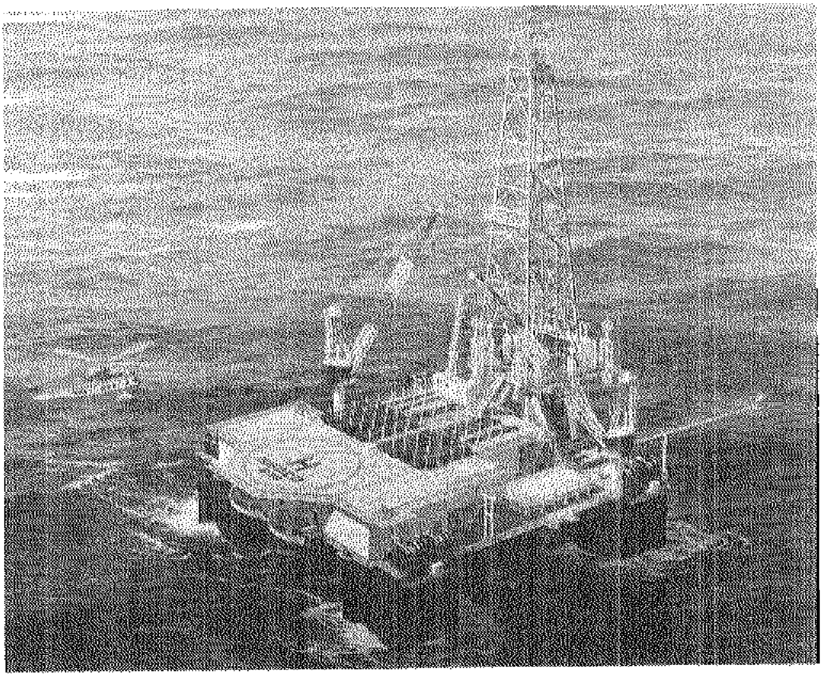


Figure 3.20 Handling Pipe on Semisubmersible. The *SEDCO 600* illustrates the derrick, cranes, helipad, gas flare boom, and on-deck storage capacity for joints, casing, and riser on a semisubmersible. (Source: Sedco Forex/Schlumberger)

is tripped out, and intermediate-hole casing is *run in* and cemented. Finally, the *bottom hole*—perhaps 8 inches in diameter—is drilled (Figure 3.21). *Cutting samples* are carefully analyzed to see if they are near *pay zone*, or oil and gas. Even though the hole may be thousands of feet deep, several *round trips*—lifting the entire drill string out, then replacing it--may be needed to replace worn drill bits (Figure 3.22). In deep wells, the round trip may take as long as 12 hours.

If petroleum is found, *production casing* is run in, generally right through the pay zone. The casing will later be perforated at the pay zone after production equipment is in place. Should casing stop above the pay zone, it is called an *open hole completion*. If, on the other hand, the well proves to be dry, it is plugged with cement and abandoned.

Well Completion. Several activities are still required to bring a well into production. First the hole (*wellbore*) must be thoroughly tested. Tests check the integrity of the casing and cement, verify the exact depth of the hole, and determine the type and amount of petroleum. *Tubing* is installed inside the casing, extending down to the production zone. A *subsurface safety valve*, which could shut off well flow if the surface controls fails, is added. At the top of the hole is the *wellhead*, the

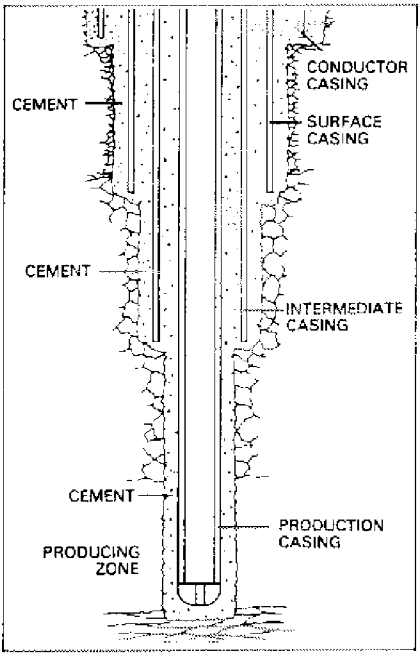


Figure 3.21 Side View of Well Hole. Conductor, surface, intermediate, and production casing are cemented in the well. The production casing is usually set through the producing zone. Note the diminishing diameter of the hole as depth increases. Although there is little correlation between well depth and loss of well control, there is a relationship between well casing and loss of well control. Two intervals appear most risky for blowouts: during drilling soon after the casing is set and during drilling as the hole nears the next casing depth. (Source: *Fundamentals of Petroleum, 3rd edition.* 1986. Petroleum Extension Service, University of Texas, Austin.)

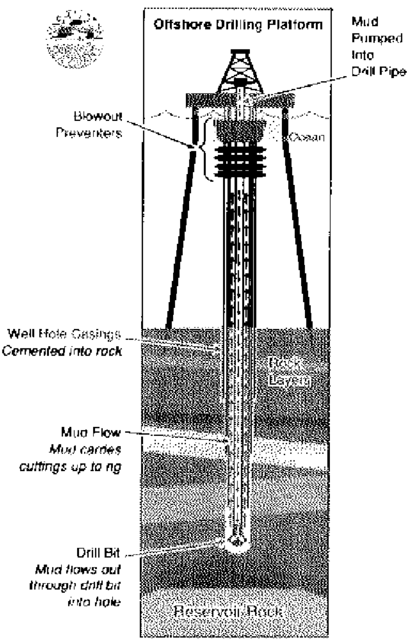


Figure 3.22 Normal Drilling Operations from an Offshore Platform.

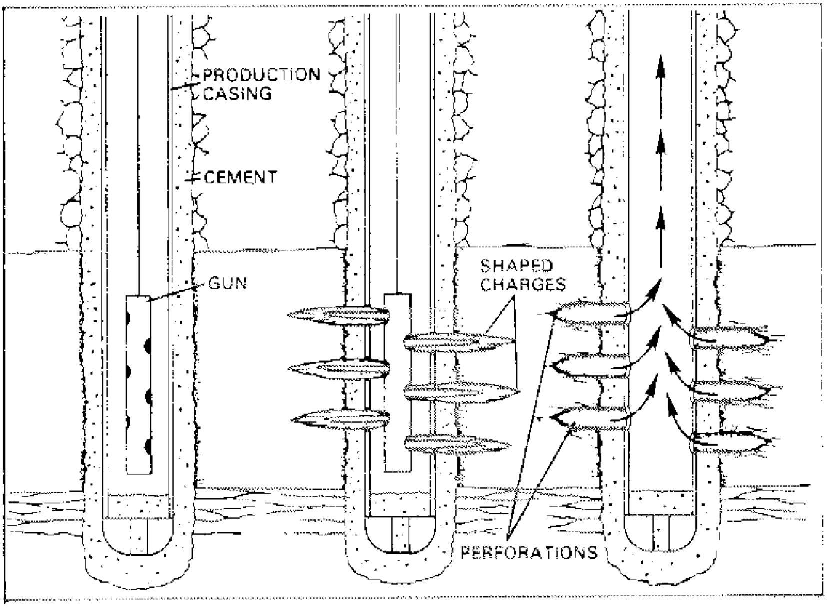


Figure 3.23 Flow from Formation into Well. A perforating gun pierces the casing and surrounding cement. The placement, size, and number of holes help control the rate of flow of the fluid from the producing zone into the wellbore. (Source: *Fundamentals of Petroleum, 3rd edition.* 1986. Petroleum Extension Service, University of Texas, Austin.)

equipment that holds the tubing and facing in place, with a Christmas tree on top to measure and control flow.

When the testing is complete and all the equipment in place, explosive charges are used to blast *perforations* through the casing and cement into the production formation so that petroleum can flow from the formation and up the well (Figure 3.23).

Primary, Secondary, and Tertiary Recovery Techniques. The above description of well completion and production applies to wells where the petroleum flows naturally out of the production zone, as most wells do when completed. But if a well does not flow, or if the production pressure diminishes over time, industry has developed several methods to enhance oil recovery (EOR). *Primary recovery* refers to the natural flow, the first phase of production from a well. *Secondary recovery* methods are used after primary recovery no longer produces sufficient hydrocarbon. *Tertiary recovery* methods may be applied after secondary methods no longer work well. In spite of all these recovery methods, recoverable petroleum averages
only about one-third of the oil or gas in place. Consequently, oil companies continue researching ways to increase recovery.

Techniques to increase primary recovery when natural flow is insufficient could include various pumps, a *gas lift* process in which hydrocarbon gas is injected into the tubing to lighten the oil coming to the surface, and ***well stimulation***, where the producing formation is treated with either acid or hydraulic pressure to enlarge channels or create fractures that improve flow. Many wells may even be *acidized* or *fractured* at the time of well completion.

Secondary or tertiary recovery methods are usually used on older wells, as natural flow decreases. The methods involve injecting something into the pores of the reservoir rock, forcing more oil out of the pores. Thus, either a new ***injection well*** must be drilled or an old production well is converted to an injection well. In ***waterflooding***, treated water is pumped into the formation, so that it drives oil to the borehole. In ***gas pressure maintenance recovery***, natural gas is pumped into the formation to maintain pressure in the reservoir. In ***miscible flooding***, a substance capable of mixing with the oil is injected. ***Thermal recovery***, another kind of enhanced recovery system, injects steam or heated water into the rock formation to lower the viscosity of oil so it flows more freely.

Separation. The fluid an oil well produces is usually a complex mixture of crude oil, gases, water, and some sediments. These components must be separated before the oil can be shipped to refineries. Thus, oil from an offshore platform generally undergoes an initial separation and treatment right on the platform (Figure 3.24). Gas may be treated somewhat on a platform or piped directly to an onshore processing plant.

The separation process includes a system of treatment facilities and holding tanks. First, in a series of separation chambers, gases and free water are separated from the oil by gravity. Then additional water is separated from the crude oil by means of heat, chemicals, or electricity. The crude oil is then stored in tanks that allow any remaining water or sediments to be drained. The separation process must carefully recover vapor, control evaporation, and eliminate fire hazard.

After the oil is measured and tested, it is ready for transport. The non-oil products of separation also require careful disposal: natural gas may be used on site, sent to market, or reinjected into the oil field or the substrate; other gases may be released or reinjected; the water—called *produced* or *formation water*—is treated and either released into the sea or possibly reinjected back into another well in the same field from which it came. Produced water may be fresh water, or, more commonly, saltwater.

Offshore Storage and Treatment Facility (OS&T). Although typically most storage and treatment is done onshore, oil storage and treatment may be completely accomplished offshore, on a specially designed island or vessel (usually a tanker) refitted to separate, treat, and store crude oil offshore (Figure 3.25). Storage is limited to what the vessel compartments can hold. An OS&T is anchored to a loading station. Crude oil arrives at the loading station by subsea pipeline from offshore platforms. Tankers load treated oil from the OS&T and ship it to refineries.

An OS&T allows development of smaller fields, where the location

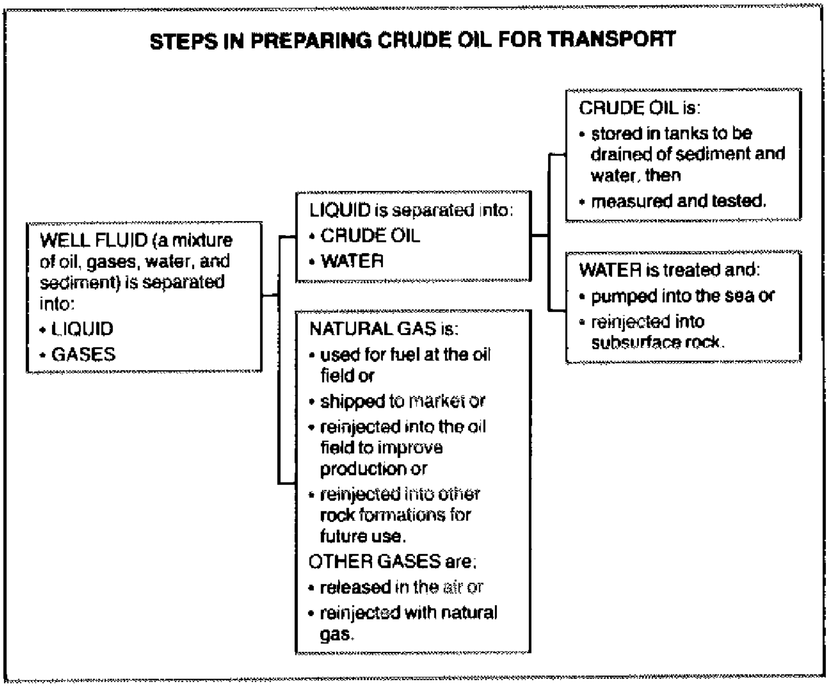


Figure 3.24 Steps in Preparing Crude Oil for Transport. (Source: *Alaskan Update*)

and size of reserves would not support the construction of onshore facilities or pipelines.

If an OS&T anchors in federal waters, it is not subject to state taxes or other state regulations, and state air quality standards may not apply (Figure 3.26). Thus, although many impacts of an OS&T would be similar to those of an onshore terminal, air emissions may be different, yet the state has no control. On the other hand, an OS&T would eliminate certain onshore benefits and adverse impacts, such as those from pipelines, tank farms, marine terminals, and tanker traffic in the harbor.

Pipelines. Oil and gas pipelines usually run from a platform to an onshore processing facility or terminal, to an offshore terminal, or to another platform. The diameter of the pipelines may vary from 4 inches to 32 or more inches, depending on the commodity or product, the anticipated volume of production, and environmental factors. Pipelines are a closed system and maintain the oil or gas under pressure.

Between the platform and the coast, pipelines may either be laid directly on the bottom or buried. They normally take the shortest feasible route between the platform and onshore storage and treatment facilities. Pipelines are more thoroughly described later in this chapter, under "Transshipment."

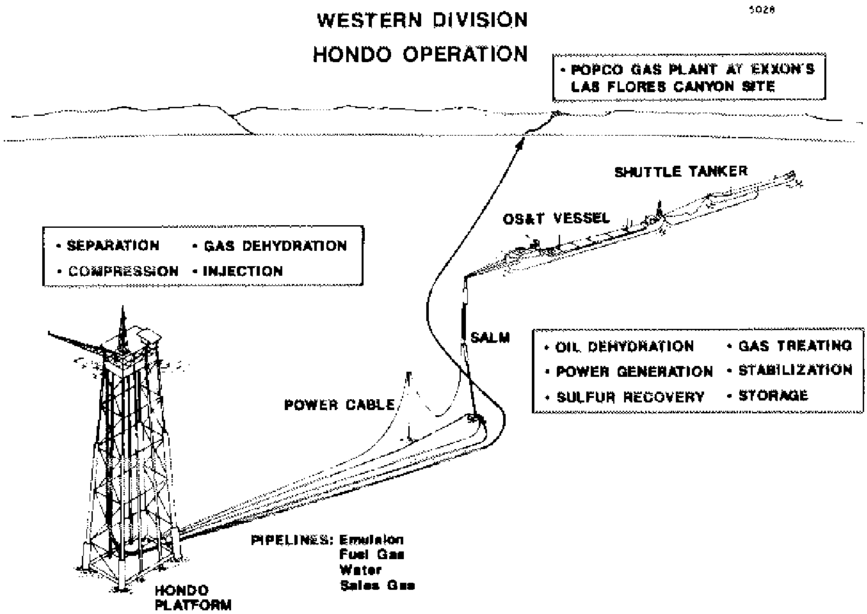


Figure 3.25 Producing Without Local Onshore Oil Facilities. Platform Hondo and *Santa Ynez* were the source of controversy in Santa Barbara, California because the OS&T vessel was anchored just outside state waters (3 miles), where it was not subject to state regulations. About one crude oil tanker per week loads at the OS&T, bound for refineries elsewhere. (Source: Exxon USA)

Preparation for Emergencies

There are two basic, potentially serious hazards from oil and gas development and production: blowouts and spills.

Blowouts. Blowouts, the sudden release of well pressure, can result during the drilling of an exploration or production well or during production. If unchecked, this pressure release will cause some release of the oil and/or gas, may allow the release of other noxious substances (such as hydrogen sulfide gas, if present), and may cause an explosion and fire (Figure 3.27). A release of natural gas may impact local air quality, but creates no spill. However, most gas wells produce some oil also, and any release of oil into the ocean is an oil spill. Fire and explosion can threaten the lives of platform workers, will destroy equipment (including possibly the existing safety systems), and may affect air quality for as long as the fire burns.

Industry uses many systems to prevent blowouts from occurring:

- Good seismic and geological information decreases the risks of

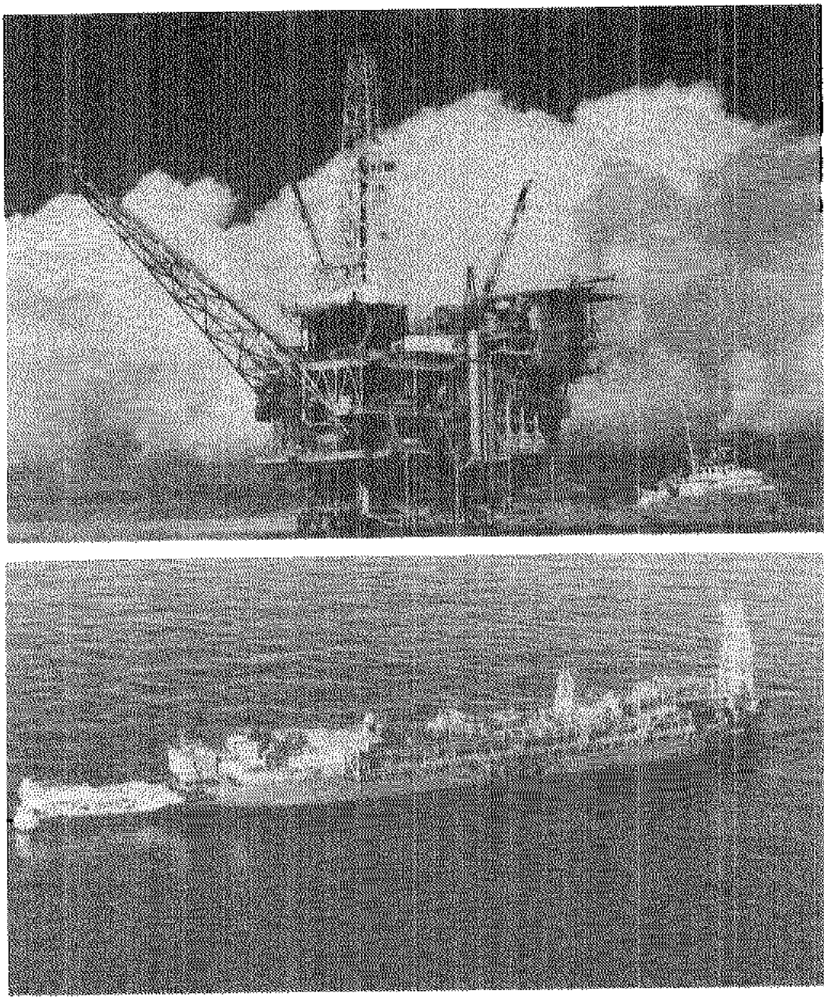


Figure 3.26 Santa Ynez Unit Production Facilities. (Top) Platform Hondo measures 945 feet from the base of its steel jacket to the top of its producing deck. It doubled the existing depth record for offshore structures at the time of its installation in 1976 and set new standards for earthquake-proof construction. (Bottom) When the OS&T *Santa Ynez* went into service in 1981, it was the first in the world. Its storage capacity is 200,000 barrels, and processing for several years has been at about 25,000 bpd. A major expansion at the Santa Ynez Unit is underway--two more platforms and new onshore facilities and a marine terminal are now under construction. The OS&T will be removed after the new system becomes operational in 1992. (Photos: Exxon USA)

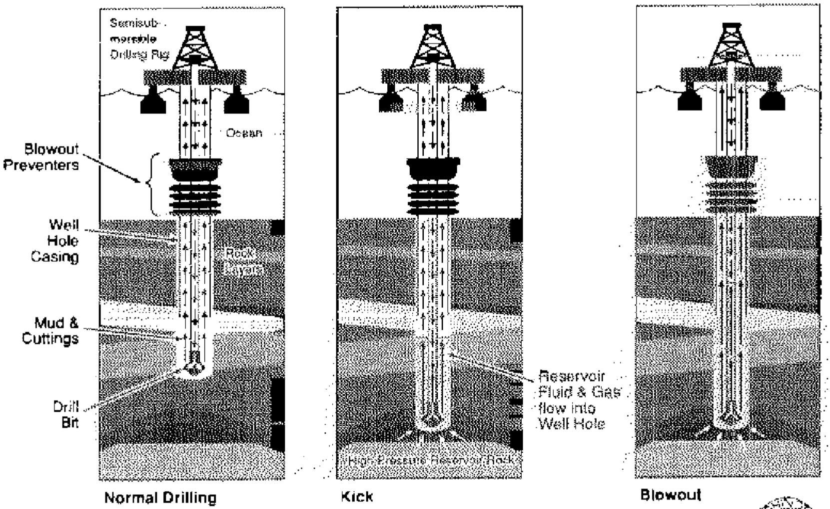


Figure 3.27 What Is a Blowout? During normal drilling operations, drilling muds help maintain pressure in the well hole equal to that of the surrounding rock. However, if a high pressure layer is encountered, reservoir fluid and gas begin to flow into the well hole. If the pressure is very great and uncontrolled, a blowout may occur. To prevent blowouts and regain control of the well, as soon as there is a "kick" or change in pressure, drillers shut down the blowout preventers and increase density of the mud.

geohazards, such as faults, and of unanticipated pressure changes during drilling.

- Careful formulation of drilling muds and fluids maintains the appropriate pressure in the well.
- Blowout preventers are designed to shut down the well in the event of any sudden change in well pressure.
- Safety systems monitor pressure changes and system integrity at all times.

A small service industry has grown around methods of fighting well fires and regaining control of well disasters. While emergency and firefighting equipment is ready on each platform, experts such as Red Adair or Boots and Coots, with highly specialized equipment, can be called in worldwide to cap wells and handle disasters. The disaster, however, may be uncontrolled for days or weeks before the specialists can begin their attack (Figure 3.28). To regain control of a well may require a relief well, which is directionally drilled to finish near the bottom of the *wild well*. Then mud is pumped down the relief well until the first well is controlled (Figure 3.29).

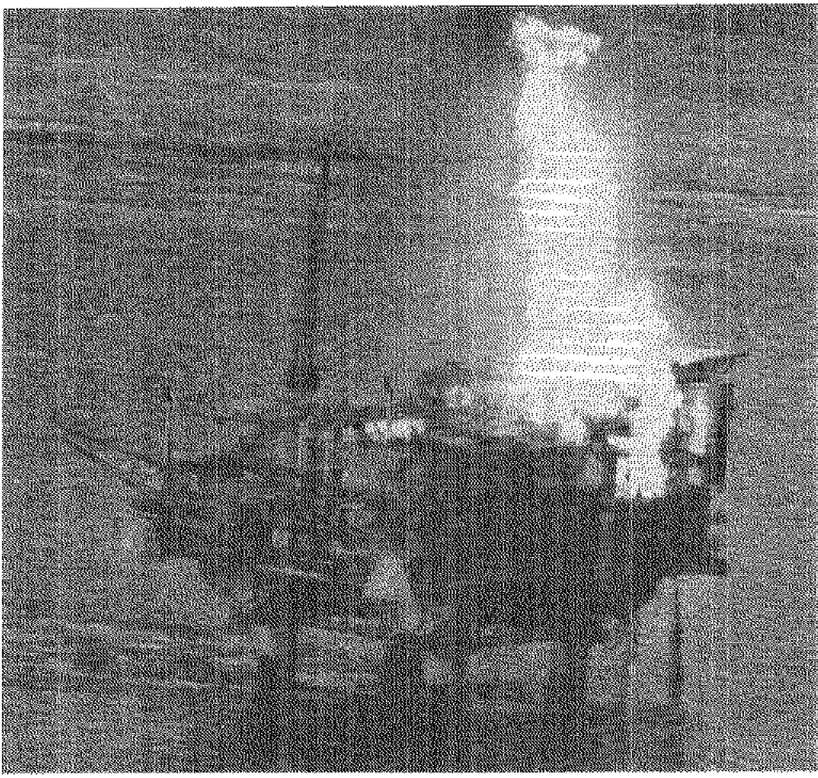


Figure 3.28 Gas Well Blowout. When Marathon Oil Company's Platform Steelhead suffered a gas well blowout on December 20, 1987, it was the sixth gas blowout in and around Cook Inlet, Alaska. Three occurred in 1962, one in 1967, and one in 1985. In the highly pressurized inlet basin, more than 785 wells have been drilled, and the discovery of four gas fields involved out-of-control wells. Forty-nine employees were safely evacuated from the $160 million Platform Steelhead, the gas was "sweet" (no hydrogen sulfide), and there was no oil spill. (Photo: *Anchorage Times)*

Despite the impressive means available for controlling wells, sometimes it is difficult to do. In Santa Barbara in 1969, it took days to stop the blowout and months to stop the spill from Union Oil Platform A[4] (Figure 3.30).

Spills. Any operations with oil—from exploratory drilling to refining and transport--carry the risk of an oil spill. Yet, not all accidents (whether blowouts, pipeline ruptures, tank ruptures, discharges, or collisions) produce oil spills, nor do all spills cause the same amount of damage. Moreover, some oil spills are not even directly related to the oil and gas industry; spills may result from other events and accidents.

Federal law requires those responsible for a spill to report it. The same law also requires the responsible party to clean up the spill. The

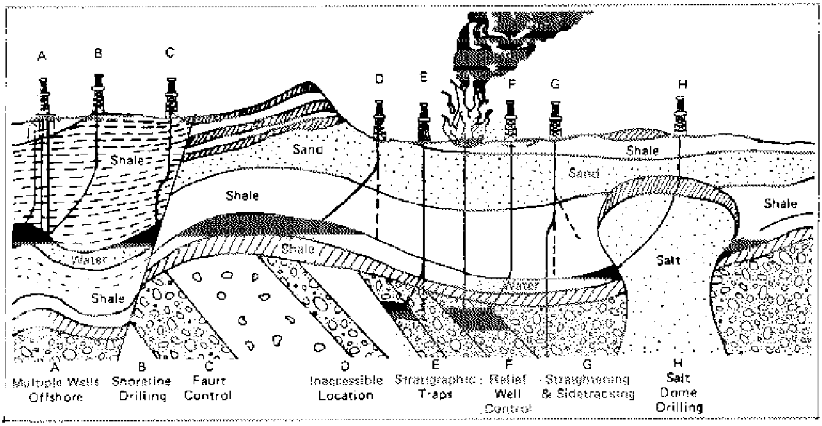


Figure 3.29 Relief Well. One application of controlled directional drilling is the relief well, sometimes drilled to help kill a blowout. (Source: *Fundamentals of Petroleum, 3rd edition.* 1986. Petroleum Extension Service, University of Texas, Austin.)

Coast Guard enforces these requirements, and must assume responsibility for cleanup if the responsible party is unknown or not acting effectively. Washington state law currently holds the person in charge of the property or product responsible for cleaning up environmental damage, but the state role is unsettled and evolving.

Once oil has spilled, protecting natural resources may not be easy, depending on the amount and type of oil spilled, weather conditions, and other factors. These factors determine how easily the oil can be contained and cleaned up. Oil spreads out rapidly over water, forming a thinner and thinner layer. Over time, as the lighter portions of the oil evaporate, the remaining oil becomes heavier, more tar-like. Eventually, oil is subject to natural degradation, depending on conditions.

Cleanup. Industry has developed considerable technology to deal with oil spills. Cleanup techniques include containment (booms), skimmers (boats or devices that siphon or skim oil off the top of the water—the principal oil recovery system), *sorbents* (which attract and absorboil), and *dispersants* (which break up or disperse the surface oil). Oil spills may also be contained and burned off if local air quality is not a problem.

Because cleanup technology is very expensive, industry usually forms a cleanup cooperative in a specific geographic area of oil production or processing. The cooperatives provide equipment, trained personnel, and cleanup plans to participating companies. The equipment, which varies depending on the needs of the participants and the conditions of that area, may include large vessels and smaller fast-response vessels, large and small inflatable booms, oil/water separation tanks, storage for wastes, trucks and trailers for moving equipment, and more (Figure 3.31). Such equipment

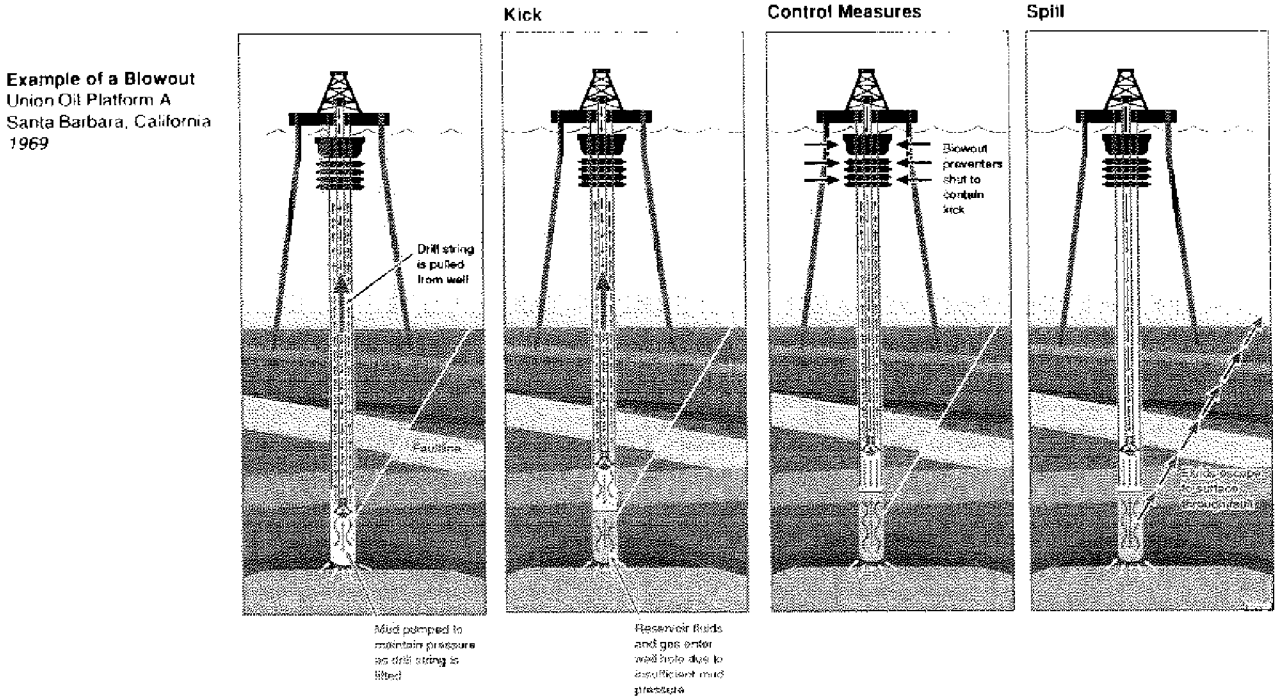


Figure 3.30 Blowout Preventers Cannot Prevent All Blowouts. In 1969, a well on Union Oil Platform A off Santa Barbara suffered the blowout that is often credited with triggering the environmental movement. This series of diagrams reveals what happened. As the crew was pulling the drill string from the wellbore, a "kick" occurred and formation fluids began to rise in the well—the start of a blowout. To contain the kick, the crew closed the blowout preventers. However, oil began to rise to the surface some distance from the well—the fluids were escaping from the wellhole through a geologic fault below the casing installation. It took ten days to stop the blowout by plugging the well with heavier mud and cement. Meanwhile, about 10,000 barrels of oil had escaped. In the next two years another 10,000 barrels seeped from this fault, and since then, approximately 400 more barrels of oil have leaked.

requires large capital investments for acquisition, maintenance, and operations.

Dispersants. Dispersants are surfactants that help break up the oil layer, causing the oil to form droplets and sink (Figure 3.32). Dispersants may also contain solvents to help penetrate the oil. As the dispersed droplets enter the water column, they are carried by currents and urdergo natural processes such as biodegradation. In laboratory and well-controlled field tests, dispersants have been effective, but for accidental spills, they have often been ineffective, possibly due to application techniques, dispersant formulation, or type of oil.

Dispersants are controversial because they are themselves pollutants and they cause local water-column hydrocarbon concentrations to increase, which can be a problem in shallow areas with poor water circulation. Any decision to use dispersants is a compromise between priorities, costs, and options: (1) the protection of birds and mammals on the surface, (2) the possible damage to life in the water column and on the bottom, (3) the interruption of an oil spill trajectory toward critical areas, such as estuaries.

Limits of Cleanup Technology. The limits of cleanup technology are most apparent in high seas. There is currently no boom that can contain oil in very rough seas or bad weather conditions. In those situations:

- Oil cannot be contained.
- Cleanup vessels may not be able to get to the spill.
- Aircraft may not be able to take off to help find the spill.
- Dispersants cannot be effectively spread.

Rough or "high energy" seas, however, will naturally disperse and weather oil, minimizing damage—if the spill does not occur near or move toward sensitive land areas. Nonetheless, critics may focus on worst-case scenarios—large spills occurring under the worst weather conditions, at the worst times and locations. These are the types of conditions that may contribute to accidents (Figure 3.33).

Onshore

Unless an OS&T is used, there is considerable construction onshore during the development phase because all the necessary storage, processing, and support facilities must be operational by the time production begins.

Permanent service and supply bases. Onshore service and supply bases support offshore operations, providing equipment, services, and supplies. They provide transportation for crew members, food, fuel, pipes, drilling muds, and solid wastes. Usually independent service contractors provide these services to the offshore industry. During exploration, temporary arrangements for a service base are adequate; during development and production, a permanent service base must be established.

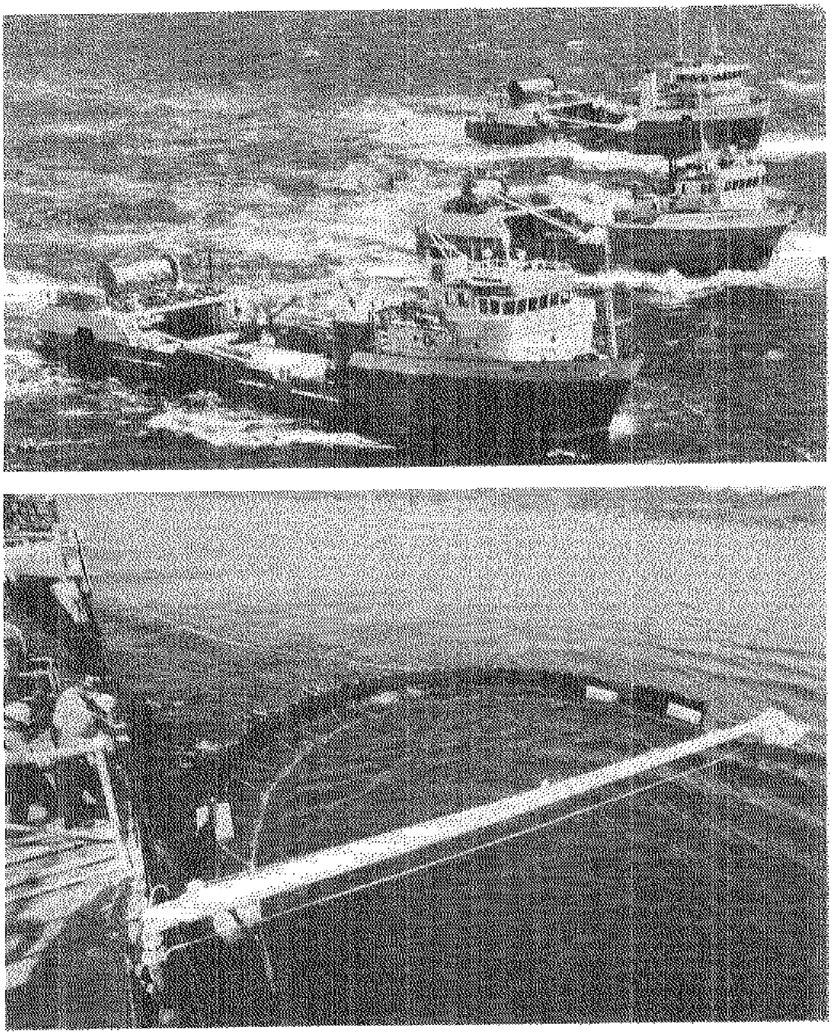
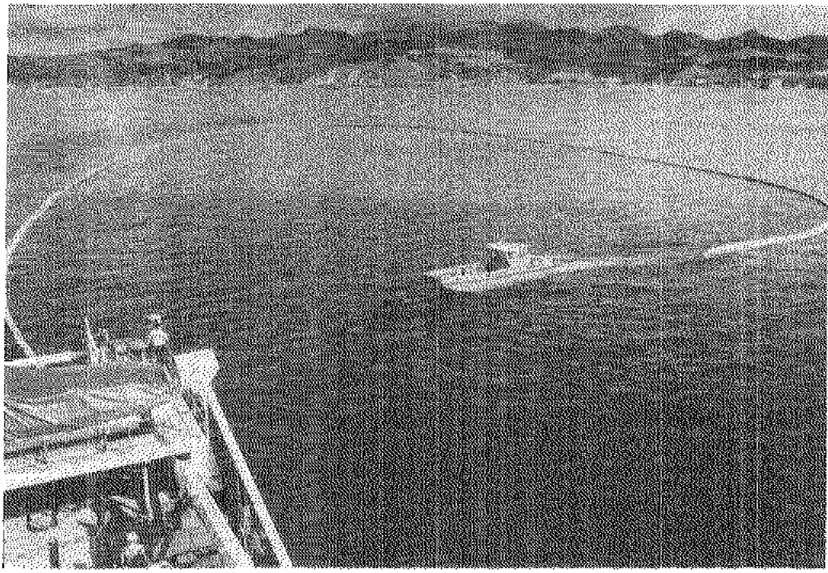


Figure 3.31 Oil Spill Cleanup Vessels. (Top) Clean Seas, the industry cleanup cooperative in the Santa Barbara area, has three large cleanup vessels, *Mr. Clean I, II, III.* (Bottom) A skimmer attached to a cleanup vessel. (Top right) A fast response vessel encircles a spill with a boom to contain the oil. (Photos: Clean Seas)

Crew members and materials are transported from the service base to an offshore facility by supply boat, crew boat, or helicopter (Figure 3.34). Thus, service bases typically provide a helipad, harbor services for berthing and supplying boats, pier space for loading and unloading supplies, warehouse and open storage space, and workspace for supervisory and communications personnel. If existing facilities—port space and storage



yards—are available, they may be used; often new private bases will be built. In California, existing port facilities must be used before a new one will be approved.

If an area has few lease sales, smaller service bases are adequate. At a minimum, a base must have ample parking and some isolation because of noise. However, if an area has several lease sales, a larger staging area is essential—warehousing and construction room become increasingly important. Supply bases such as Port Hueneme, California, require 50 to 80 acres of level terrain, with good road and rail access.

Marine (Oil) Terminals. A marine terminal is one part of a transportation system. At a marine oil terminal, there is a change in mode of transportation, usually between pipeline and a vessel. Thus, regardless of where an oil terminal is and what it looks like, it must have the means to moor vessels, to load or unload them, to store oil in large tanks, and to pipe oil to and from the tanks (Figure 3.35). A power transmission system is also necessary to move the oil and supply the needs of the terminal and tankers.

Marine oil terminals usually receive oil from an offshore facility by pipeline. If necessary, the oil goes to an onshore separation and treatment facility to remove impurities, then to the storage tanks to await loading aboard a tanker. If the oil has already undergone offshore separation, it may be moved directly to the storage tanks, where it is stored for eventual shipment.

An oil terminal can be located offshore or onshore. Onshore oil terminals need water frontage if they use a fixed berth moorage system such as a pier or wharf, but not if they use a floating berth, connected to the

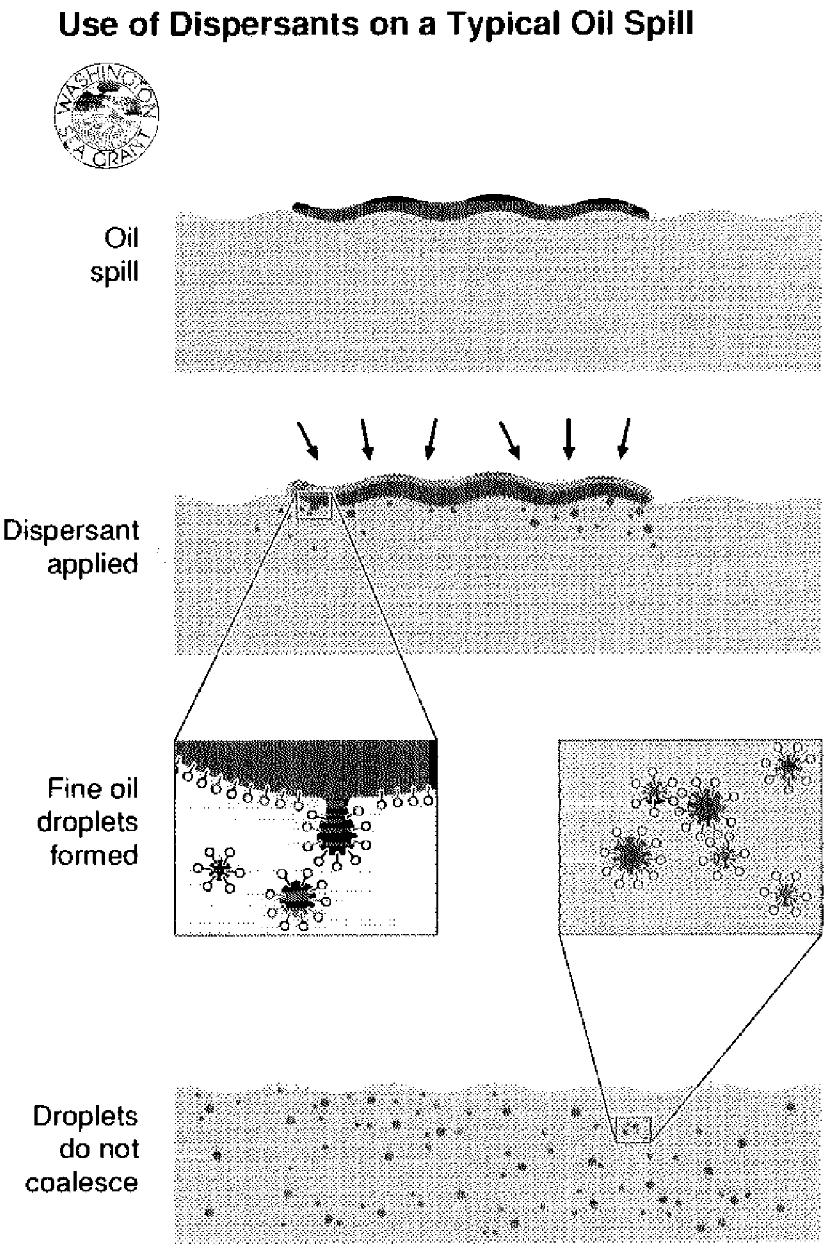


Figure 3.32 Oil Spill Dispersants. Under certain conditions, dispersants can be used to break up oil slicks.

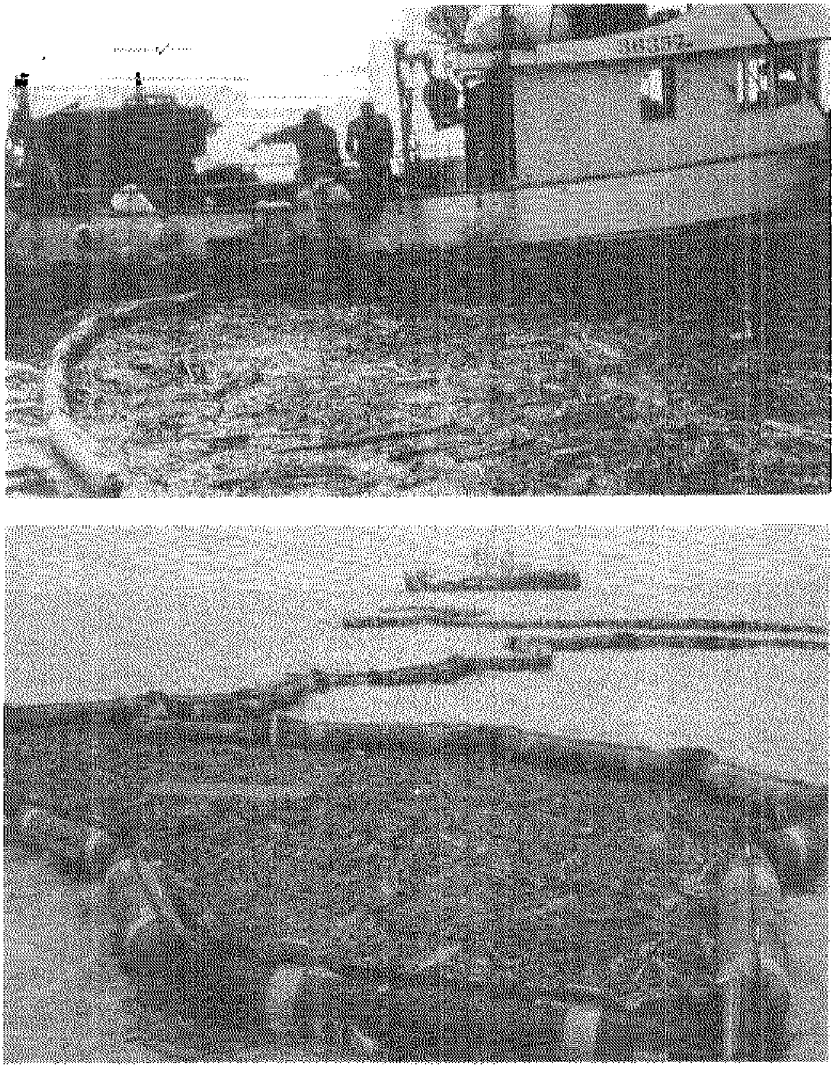


Figure 3.33 Oil Spill During Salmon Run. In July 1987, the tanker *Glacier Bay*, grounded and began leaking oil in Cook Inlet, Alaska. Oil continued leaking for several days, until the U.S. Coast Guard stepped in to coordinate cleanup. Fishermen were particularly concerned because a major salmon run was due shortly. In a novel approach, the Coast Guard, lacking sufficient high-tech cleanup equipment, enlisted the fishermen as volunteers to help clean up the spill. (Photos: U.S. Coast Guard)

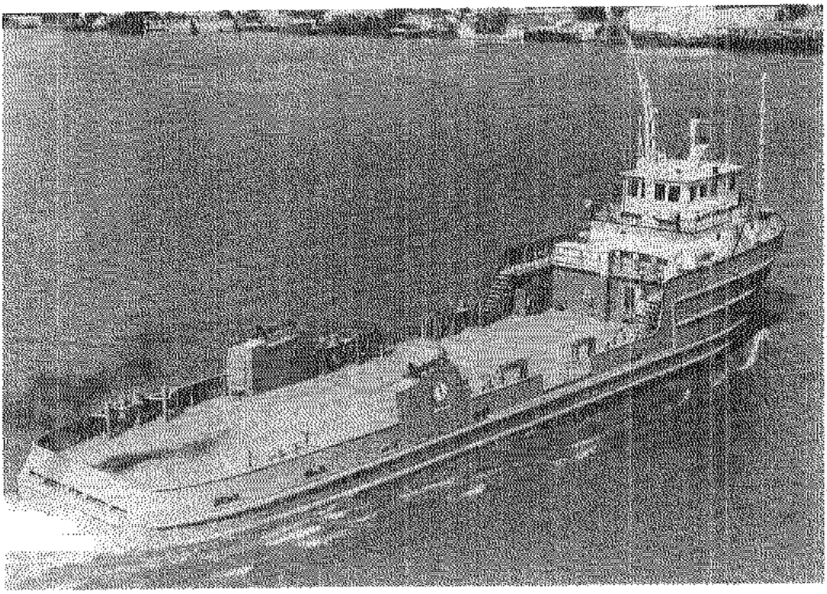


Figure 3.34 Gulf Coast Supply Boat. The long, open deck is designed to carry quantities of drill pipe and other bulky supplies and heavy equipment needed for offshore operations. (Photo: Jesse Grice, Photo Mart, Morgan City, Louisiana)

storage facilities by subsea pipeline. In either case, the storage facilities can be built near the waterfront or somewhat inland.

There are a variety of berthing systems that can be used with an offshore terminal or any floating berth. A ***single point mooring*** allows the vessel to rotate or "weathervane" around the mooring, giving the least resistance to wind, waves, and currents. Alternate possibilities are ***multi-buoy moorings***, which do not allow rotation of the berthed vessel, or ***fixed sea islands***, which also allow the vessel no movement. In exceptional cases, storage tanks for an offshore terminal can be floating and anchored or submerged and fixed to the seafloor.

The size and number of storage tanks in a marine oil terminal depend on such factors as the need for the oil, the need for timely loading or unloading of vessels, the distance to the refinery, and the reliability of continuous delivery. An *onshore tank farm* consists of the tanks, dikes to hold the oil in case of a spill, safety and emergency equipment, pumps and pipelines that can distribute the oil to specific tanks, and access roads. The tanks themselves may be of several shapes, below or above ground, heated or refrigerated, with fixed or floating roofs to reduce evaporation and odors.

Separation and Treatment Plants. Although the separation and treatment of crude oil or natural gas generally begins offshore, it is often completed onshore. There are often treatment facilities located in combination with a marine terminal, an oil refinery, or a gas processing

Figure 3.35 Pipeline at Gaviota. Underwater and underground pipelines link three platforms at Point Arguello with the Gaviota oil and gas treatment plant and marine terminal. Texaco owns Platform Harvest, and Chevron owns Platforms Hidalgo and Hermosa. PAPCO, a partnership of 12 companies, owns the 250,000 bpd "wet" oil line from Platform Hermosa to the plant, while PANGLCO, a partnerhip of 10 companies, owns the 160 million scfd gas line. These pipelines cost about $135 million. Chevron USA is the managing partner for both lines and the plant. Texaco is the managing partner for the owners of the marine terminal. (Source: Chevron USA)

plant (Figure 3.36). Separation and treatment plants require considerable energy to heat and process oil, and thus may result in significant air emissions.

Before refining, crude oil must be separated from any gases, water, sediments, and impurities such as hydrogen sulfide. Separation is accomplished by series of separation chambers and treatments with heat, chemicals, and electricity, and the process yields useful products and wastes (Figure 3.37).

The crude oil is then stored in tanks or sent to refineries or processing plants. Natural gas may be used on site or sent to market. Other gases and produced water may require treatment before being disposed of or released.

Natural gas processing removes natural gas liquids, liquid petroleum gases, water, hydrogen sulfide, and carbon dioxide from the offshore gas to make it acceptable for injection into a natural gas pipeline network. Since it is important to control delivery pressure, gas processing also includes compression and pressure-reducing regulators, as well as temperature conditioning. Gas treatment and processing can be within or totally separate from an oil treatment and processing plant. *Natural gas*

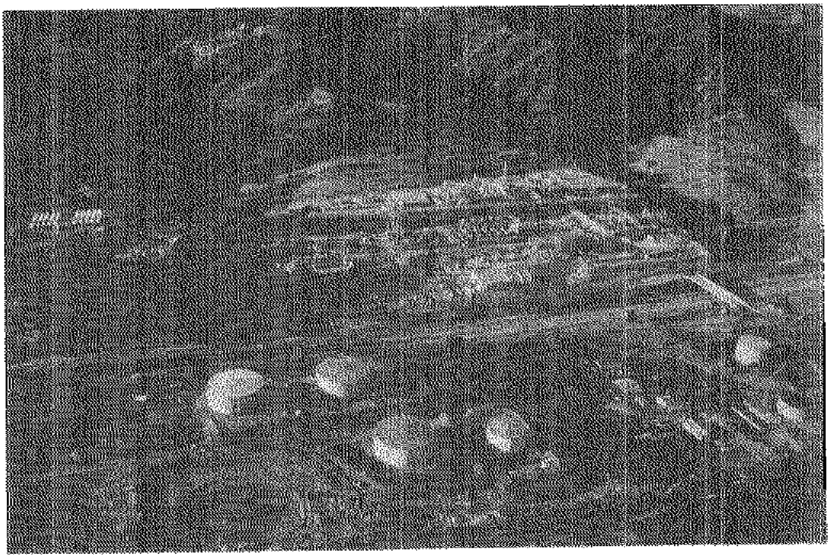


Figure 3.36 Gaviota Oil and Gas Plant. West of Santa Barbara, California, the Point Arguello Project involves 18 operating companies organized in three partnerships. The separation and treatment facility currently can produce 100,000 bpd of "dry" crude oil (ready for refining), 48 million scfd of clean natural gas (ready for sale), and smaller amounts of propane, butane, natural gas liquids, and sulfur (also ready for sale). When operational, the plant will create about 125 permanent jobs. (Photo: Chevron USA)

processing plants are usually designed to remove certain valuable products over and above what is needed to make the gas marketable.

Refineries. Oil refineries convert crude oil into various petroleum products, including fuel oil, gasoline, propane, kerosene, and asphalt. A refinery requires considerable water and power to operate.

A modern refinery will include processing units, storage units, and associated components such as utilities, safety equipment, oil spill cleanup equipment, machine shops, laboratories, and waste handling equipment. In general, a refinery receives crude oil by pipeline or tanker, and temporarily stores the oil in tanks. The oil is distilled, refined, and blended into final products that are stored for shipment. A refinery does not need to be located on a coast, but if it is, it will need pipelines to connect it with a marine terminal, so that crude oil and refined products can be transported by tankers and barges. Transportation costs make it more profitable to locate oil refineries near the prime market for the products.

Several refineries currently operate within Washington. Texaco and Shell have refineries in Anacortes (with 1987 capacities of 78,000 and 77,000 barrels per calendar day [bpcd], respectively); Mobil operated a refinery in Ferndale (77,000 bpcd) until October 1988 when it was sold to Sohio, a subsidiary of British Petroleum; ARCO has a refinery at Cherry

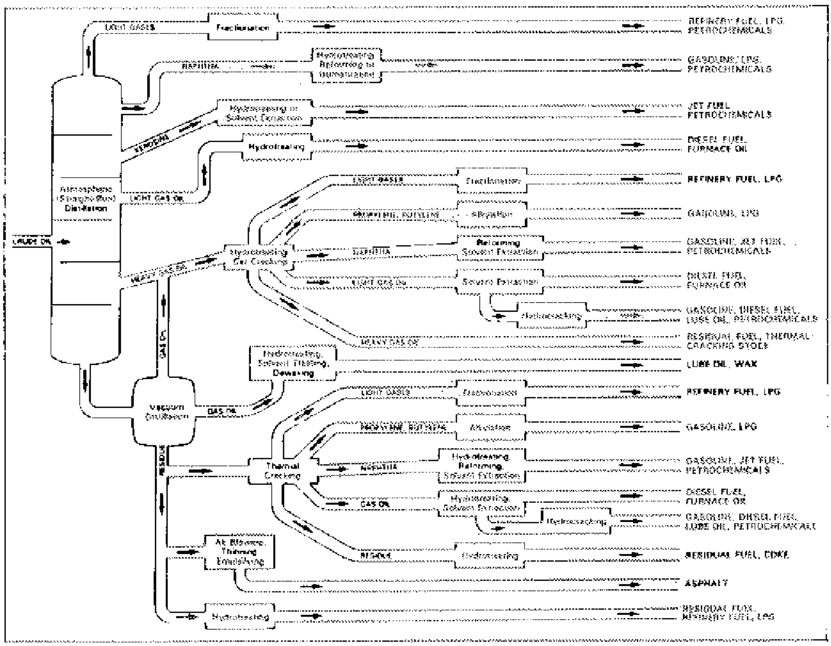


Figure 3.37 Refined Oil Products. A variety of processes are used to convert crude oil into many "light" to "heavy" products. (Source: *Fundamentals of Petroleum, 3rd edition*. 1986. Petroleum Extension Service, University of Texas, Austin.)

Point (163,000 bpcd); and U.S. Oil operates a refinery in Tacoma (32,000 bpcd) (Figure 3.38).

Petrochemical plants. Petrochemical plants produce a variety of products from oil refinery products and from natural gas liquids. Products could range from toluene, benzene, and ethylene to plastics, synthetic fibers, paint, and tires. Because it is usually cheaper to ship crude oil and liquefied natural gas than to ship refined products, petrochemical plants are more profitable if they are near the large markets for their products. Also, they will generally be onshore and near the refineries. Petrochemical plants require ample energy supplies and access to other chemical industries for additional resources.

Ammonia/Urea fertilizer plant. A plant that produces ammonia and fertilizer from natural gas can be established with low investment and operating costs. Thus it is an attractive industry to investors if there is a demand for the products. The plant requires that natural gas be readily available by pipeline and that an efficient shipping system distribute the product (Figure 3.39). Waste products are minimal. Alternative means of creating fertilizers from crude oil are not as efficient or clean.

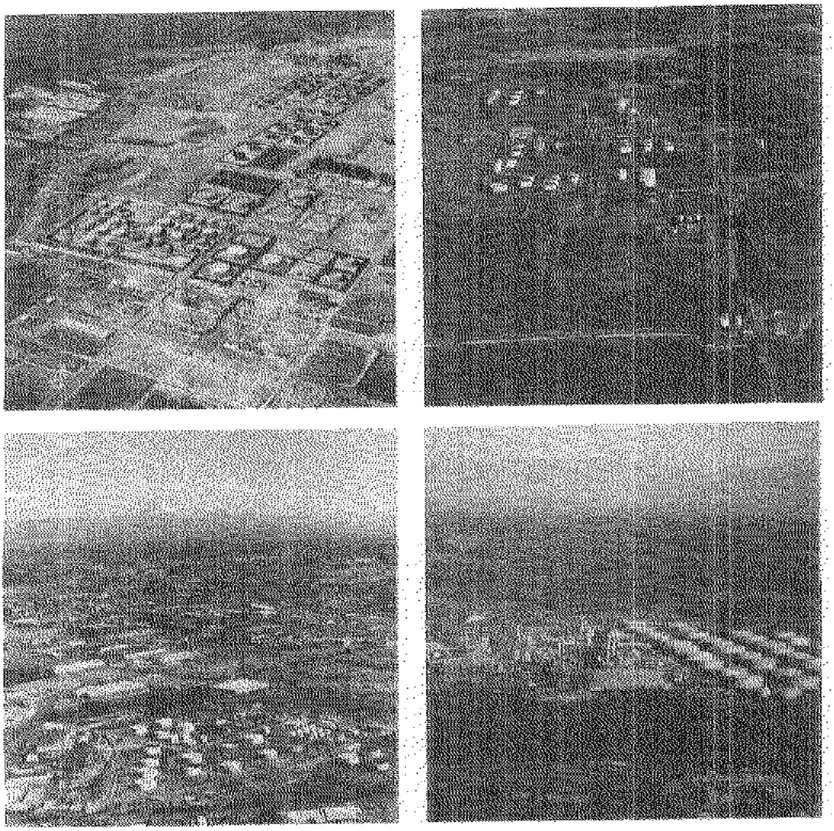


Figure 3.38 Five Washington Refineries. *Top left:* Two refineries at Anacortes. In center foreground is the Texaco refinery which is just south of the Shell refinery near top of photo. *Top right:* The oldest refinery in the state was at established in 1954 at Ferndale. The Mobil Oil refinery was sold to Sohio, a subsidiary of British Petroleum, in October 1988. *Lower left:* ARCO Cherry Point refinery, Ferndale. *Lower right:* U.S. Oil refinery at Tacoma. (Photos: Texaco, Mobil, ARCO, U.S. Oil)

Liquefied Natural Gas (LNG) plants. LNG plants provide the one option for transporting natural gas to markets that cannot be served by pipeline. By cooling and compressing natural gas to a liquid form, 600 cubic feet of natural gas become one cubic foot of liquefied natural gas, a clear, colorless liquid that consists mainly of methane. An LNG plant receives gas by pipeline, conditions it to remove water and impurities, then chills it through three progressive cooling systems until the natural gas is a sub-cooled liquid at -259°F. The LNG is transferred to heavily insulated storage tanks, and eventually to cryogenic tankers for transport to the market area (Figure 3.40). The receiving market must have regassification facilities to change the LNG back to the usable gaseous state.

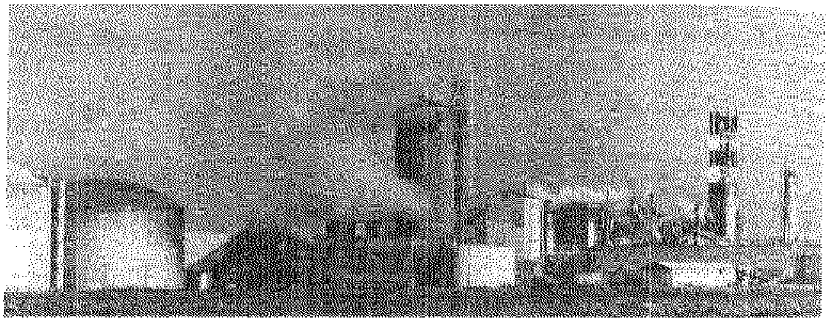


Figure 3.39 Unocal Chemical Plant, Kenai, Alaska. The ammonia and urea produced here is barged to Washington and Oregon, among other destinations worldwide. (Photo: Unocal)

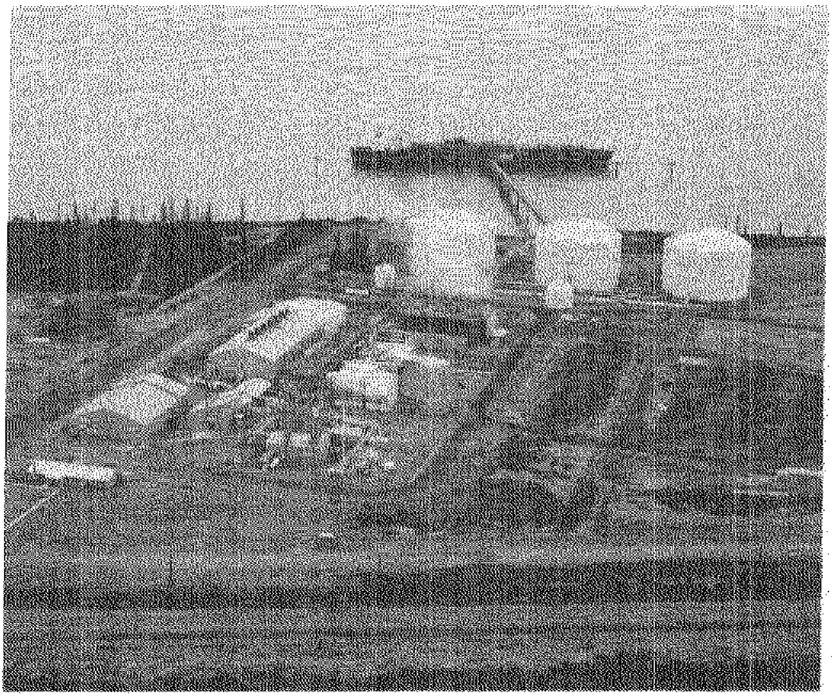


Figure 3.40 LNG Tanker. Liquefied natural gas (LNG) is loaded at the Phillips Petroleum marine terminal in Kenai for export to Japan. (Photo: Phillips Petroleum)

There are two basic hazards with LNG: (1) it is a cryogenic gas that causes great thermal stresses in materials exposed to it, and (2) it is a flammable liquid that readily vaporizes, creating a risk of explosion and fire.

An LNG plant is not likely if it is possible to get the natural gas to market by pipeline. An LNG plant would be built only in situations where all the following conditions exist:

- The local supply of natural gas far outpaces the local market need.
- There is a deepwater port.
- Other transport methods are not available.
- Enough land is available to support the LNG facility and provide a buffer zone to insulate the plant from any nearby population.

Transshipment

The transportation system from producing offshore wells must move immense quantities of crude oil—over 10 million barrels a day are transported from producing fields in the United States to refineries. The products of the processing then must be distributed to various markets. The petroleum industry depends on economical and efficient transportation using a system that includes pipelines, tankers, barges, highway tank trucks, and railroad tank cars. The mode of transporting crude oil and petroleum products is selected based on (1) the volume of liquid or gas to be

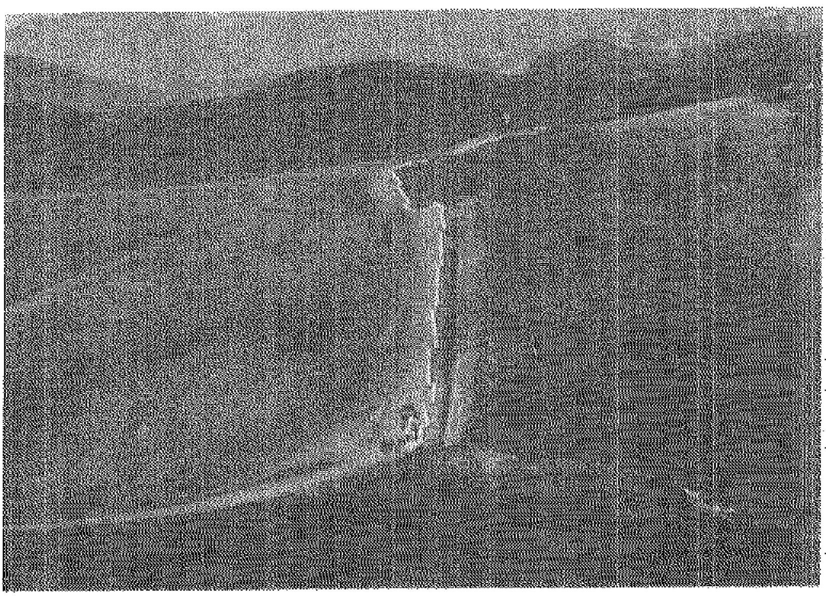


Figure 3.41 Pipeline Burial Onshore. Two parallel pipelines were buried five feet under the surface from Point Conception to the Gaviota Oil and Gas Plant west of Santa Barbara. (Photo: Chevron USA)

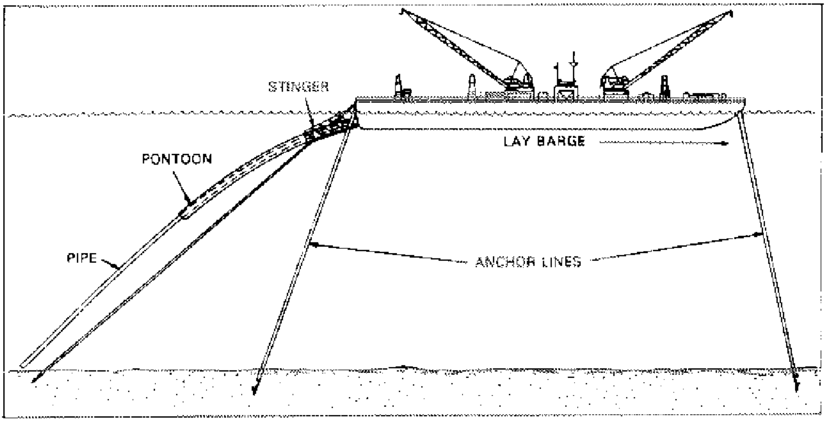


Figure 3.42 Pipelaying at Sea. The stinger guides the pipeline safely to the seafloor while the lay barge moves by winching in on the forward anchor lines (right) and slacking off on aft lines (left). (Source: ***Fundamentals of Petroleum, 3rd edition***. 1986. Petroleum Extension Service, University of Texas, Austin.)

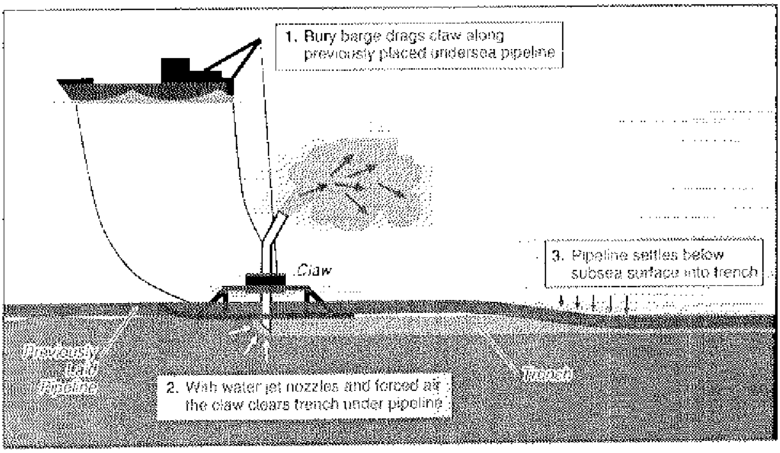
transported, (2) the price of oil or gas, (3) the distance the material is to be transported and the character of the terrain, (4) characteristics of the point of origin and the destination, and (5) the expected lifetime of the transportation system and any possible expansion plans. During oil and natural gas production, the modes of transportation that are feasible are pipeline or tanker, though barges may be useful in some situations.

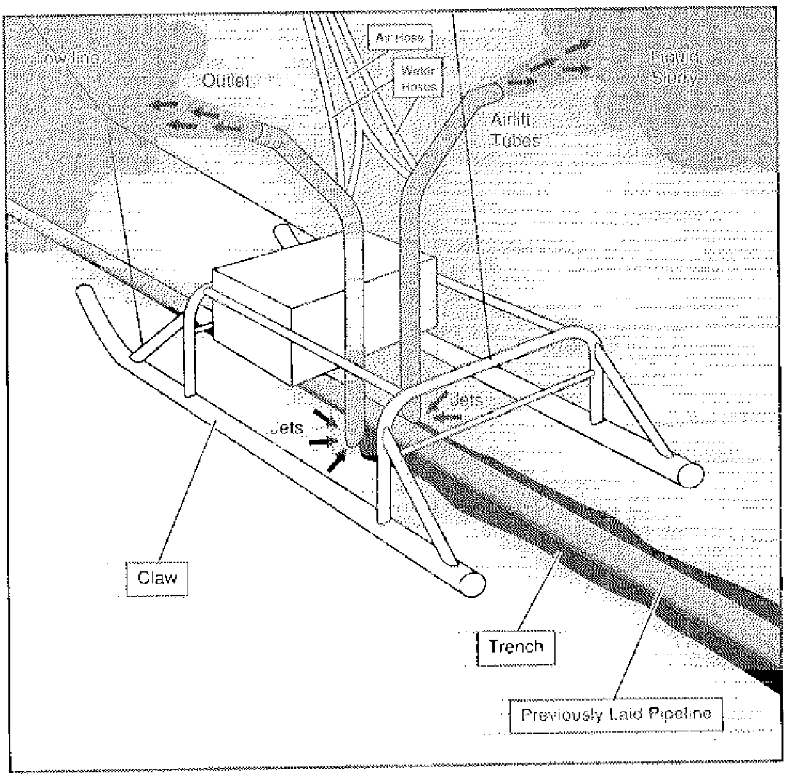
Pipelines. Pipelines are generally considered the most efficient, economical, and safe method of transporting oil or gas, by both the public and the industry (Figure 3.41). The drawbacks of using pipelines are that they limit transportation to fixed routes and destinations and they can be very difficult to install in certain areas (Figure 3.42). Pipelines of different diameters are used extensively in oil and gas production and transportation. Pipelines are always used to transport natural gas from the offshore production site to shore.

Construction of oil pipelines and gas pipelines is similar, but intermediate and terminal facilities differ. Gas pipelines have compressors instead of pumps. Gas pipelines use pressure control as a basis for operation, while liquid pipelines work on the basis of controlling rate of flow. Oil pipelines have just enough pumping stations to keep the oil moving efficiently, at a speed of three to five miles an hour. If the volume of oil increases or mountainous terrain is encountered, additional pumping stations can be added.

Pipelines are generally constructed by welding together lengths of steel pipe. Their diameter depends on their capacity and function. A trunk line might be 24 inches; the Trans-Alaska Pipeline is 4 feet in diameter. Other pipelines could be as small as 4 inches. *Flow lines* carry crude oil

Pipeline Trenching Operation





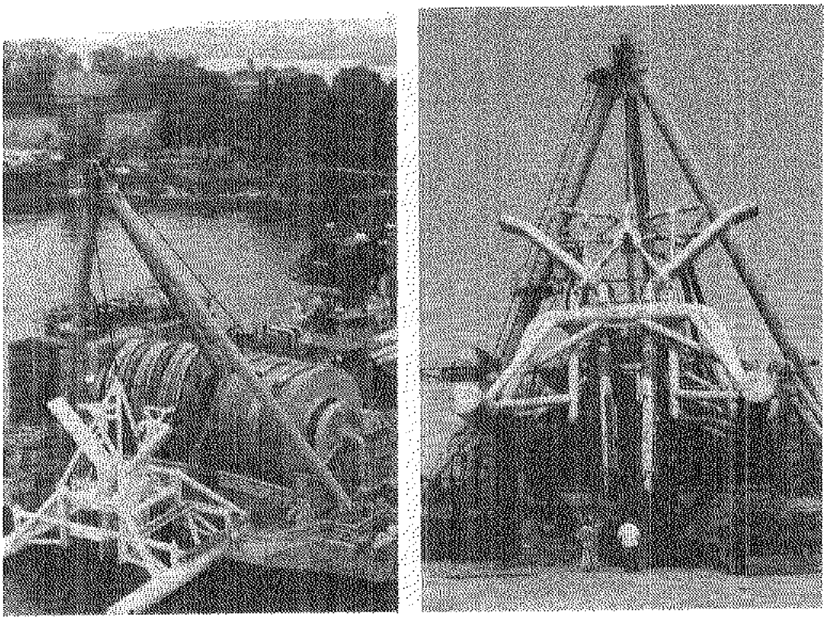


Figure 3.43 **Pipeline Trenching for Stability and Safety.** (Opposite) A "claw" is lowered from a bury barge and positioned by divers a-straddle the pipe. Water and air are pumped through the claw. The water is forced out small jet nozzles at high pressure and velocity, cutting into the sediments. The escaping air lifts the suspended sediment and discharges the liquid slurry through the airlift tubes. While the air rises to the surface, the sediment sinks alongside the pipeline. As the barge drags the claw forward, the pipeline settles into the new trench, which is often left open, to be back-filled by natural processes. A newer burial technique, using polypropylene mats, is being introduced (see Figure 3.52). (Above) Pictured for a sense of scale is the raised claw at the stern of *BAR 280* which was berthed at Sabine Pass, Texas in May 1988. (Photo: B. Glenn Ledbetter, ORAP)

from producing wells to field storage tanks. *Gathering lines* connect these tanks to *trunk* pipelines, which are the long distance carriers that usually end at a processing or refining facility or a marine terminal.

Inspectors, input/output monitors, and pressure monitors can check for leaks. Divers can monitor the integrity of subsea pipelines. The newest systems can also be checked by passing a sophisticated computer probe (a *smart pig*) through the pipeline. Warning alarm systems and both manual and automatic safety valves also protect the line should pressures drop below or rise above predetermined levels. Often, there is a central control station from which an operator can control pumps, regulators, valves, and compressors along an entire pipeline system.

Marine pipeline design must account for bathymetry, bottom conditions, currents, corrosion, and potential damage from other users of the

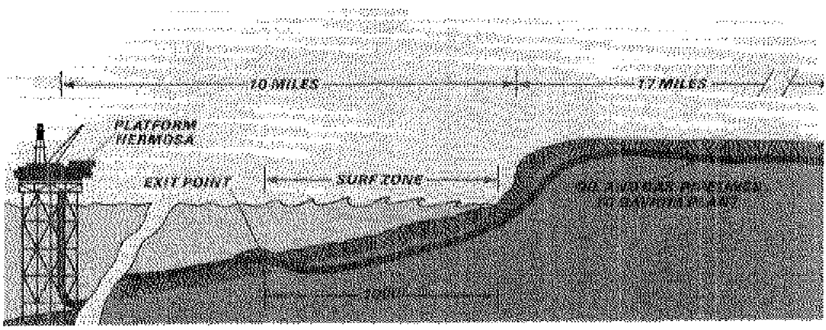


Figure 3.44 Pipeline Burial at Pt. Arguello. An oil pipeline (24-inch diameter) and a gas pipeline (20-inch diameter) extend from Platform Hermosa at Pt. Arguello, California, to the Gaviota plant west of Santa Barbara. Throughout the 1000-foot surf zone and for 17 miles on land, the pipes are buried. The portion under the surf zone involved slant drilling from ashore. (Photo: Chevron USA)

sea floor, such as ships' anchors or trawlers. Cathodic and concrete coatings help protect against corrosion and anchor pipelines. To help protect the pipelines from high energy ocean conditions and to provide minimum interference for trawling and crab fishing, pipelines may be buried either by trenching (usually in soft bottoms only) or by covering with gravel or other material (Figure 3.43). The high energy surf zone poses special problems where the pipelines emerge—at that point pipelines may be buried or raised on trestles (Figure 3.44).

Subsea pipelines are installed either by lay barges in deep, open water, or from a staging area on the coast. The lay barge method involves welding the lengths of pipe on the barge and placing the continuously welded length into the ocean by winching the barge forward from huge anchors placed ahead of it. When a staging area onshore is used, pipe lengths are welded onshore and pulled offshore with tugs or by powerful winches on a barge moored offshore. Though not inevitable, both methods can leave bottom scars that can damage trawl fishing gear. New equipment allows large diameter pipelines to be put in deeper water. For example, semisubmersible barges can lay 36-inch pipes in up to 1,000 feet of water, and vessels using reel-type equipment can lay 12-inch pipe in 3,000 feet of water (Figure 3.45). The lay barge *BAR 323* can lay pipe up to 56 inches in diameter (Figure 3.46).

Construction of onshore pipelines requires a staging area and a 200-foot wide construction right of way for machinery. Building pipelines in remote areas may require access or road improvements as well.

To minimize impacts, several companies may commingle or batch products into one industry pipeline for transport.

Tankers. Pipelines often end at marine terminals, where crude oil is transferred to tankers or barges to continue its journey to refineries. Refined products also may travel by tanker or barge to major distribution

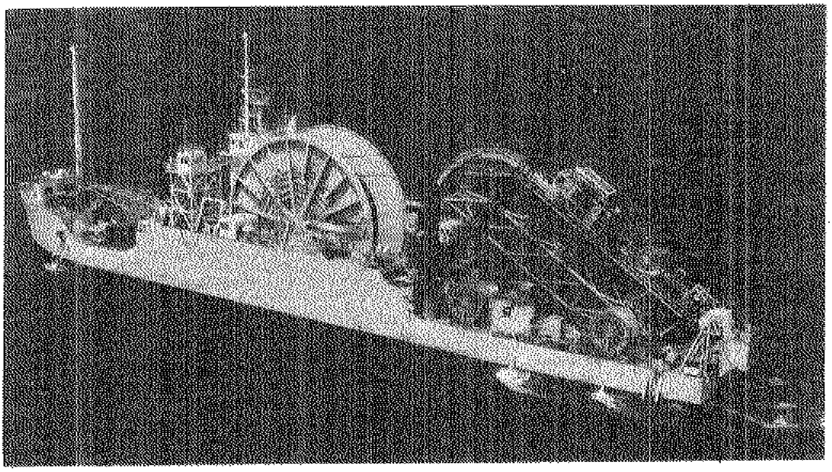


Figure 3.45 Pipelaying Reelship *Apache*. Built in 1979, the 403-foot *Apache* has 12-knot speed and 18-foot draft with quarters for 123 men. The four-point mooring system includes two 30,000-pound bow anchors and two 20,000-pound stern anchors. Pipe handling, welding, coating, and spooling are accomplished at the spoolbase onshore. The flange diameter of the vertical reel is 82 feet, and its capacity is 2000 short tons. It can handle from 50 miles of four-inch to almost 6 miles of 16-inch continuous steel pipe. *Apache* is designed to lay 12-inch pipelines in up to 3000 feet of water. (Photo: Santa Fe Offshore Construction Co.)

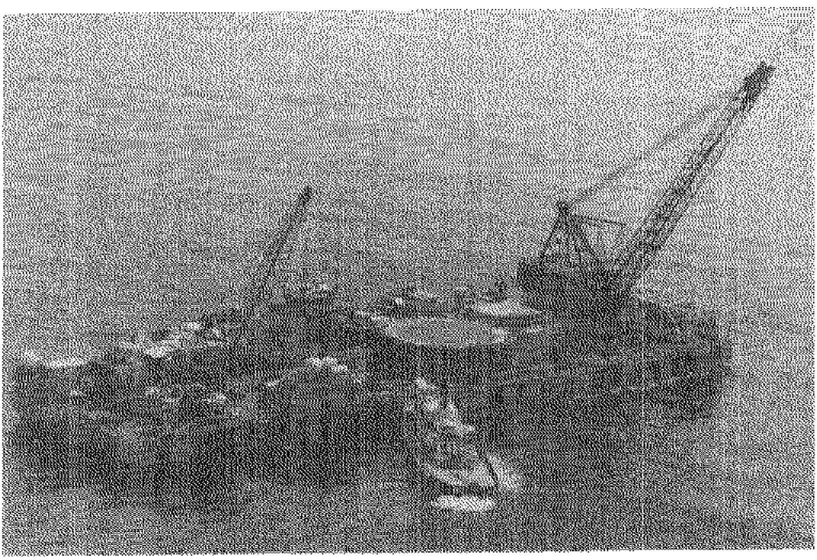


Figure 3.46 Pipelay Barge. *BAR 323* is designed to lay pipe up to 56 inches in diameter. (Photo: Brown & Root)

centers. Also, there are tankers for liquefied natural gas (LNG) and liquefied petroleum gas (LPG).

Many factors drive industry's decisions on transportation mode. Transporting petroleum by tanker allows industry maximum flexibility—options to send the crude oil or product to a totally different processing plant or market, if desired. Also, the capital invested in tankers remains usable, regardless of what fields are producing or facilities operating, while that invested in a pipeline is lost, should a field no longer be profitable to produce, leaving a pipeline empty. On the other hand, tankers are somewhat more subject to certain variables: weather problems may cause costly delivery delays; operating expenses are more subject to economic variations; political problems might threaten security on the open waters; marine traffic faces a greater risk of accident or collision than pipelines do; chance of spillage increases each time the transportation mode changes, for example from terminal to tanker to terminal; and oil spills on the sea are potentially more damaging and complicated to clean up.

Each day, millions of barrels of crude oil and products are in transit in tankers on the high seas. Most of the American tanker fleet operates in coastal and intercoastal trade, carrying crude oil between producing areas and refineries. In addition, since the United States currently imports over 40% of its oil, tankers from the world fleet, flying the flags of many countries, frequently call at U.S. ports.

Tankers are specialized merchant vessels with the hull designed to carry liquid cargoes in compartments. They have equipment for onloading and offloading, a ballast system to keep the ship stable, and safety systems to monitor the compartments. Although some tankers are double-hulled, providing additional security for the oil cargo in the event of vessel damage, most tankers have a single hull (Figure 3.47). Most of the coastal tanker traffic is made up of mid-sized vessels (30,000 to 80,000 deadweight tons) (Figure 3.48). *Supertankers* (100,000 to 500,000 deadweight tons) ply certain long-distance hauls, but few ports can manage the massive vessels. Small tankers may be used on rivers and lakes.

Presently there are vessel traffic systems to oversee marine traffic in Houston, San Francisco, the Puget Sound area, and at Valdez, Alaska. Compliance with vessel traffic systems is voluntary: there are no penalties for noncompliance (in contrast to air traffic control systems). Once outside of harbor areas, there are no shipping lanes or traffic regulations to which tankers must conform, except for the customary "Rules of the Road." Voluntary towboat lanes off the coast near Grays Harbor have been negotiated between towboat operators and crab fishermen (shown in Chapter 5 as Figure 5.5).

Barges. Crude oil can be stored and transferred to barges at the field site. Barges frequently carry refined products. Today's barges are streamlined carriers that may be self-propelled, towed, or pushed by tugboats. Barge operations, however, are normally limited to shallow water areas with mild sea conditions, such as inland waterways along the Gulf

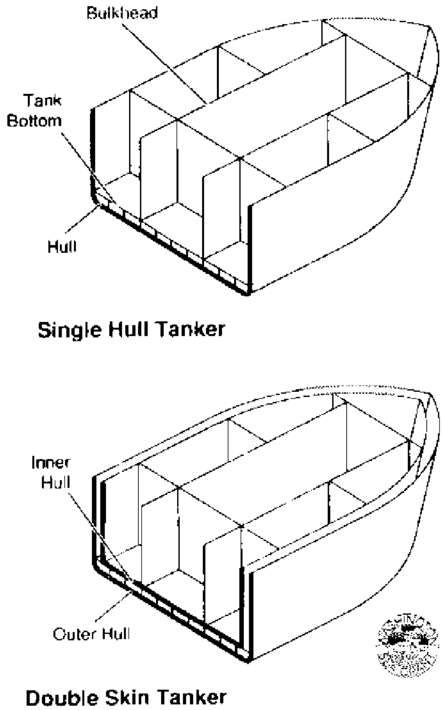


Figure 3.47 Tanker Hull Types. Conventional tankers have a single hull, but some oil tankers are constructed with two complete steel hulls as a safeguard against spillage if the outer hull is pierced. These double-skin tankers are uncommon and expensive. Double bottom tankers (not shown) afford similar protection for the bottom but not the sides of such tankers.

Coast or the Columbia River between Vancouver, Washington and the Tri-Cities. There are some large sea-going barges with capacities of up to 250,000 barrels. Along the Middle Atlantic Coast, barges receive ocean tanker cargoes and carry them to inland storage centers, refineries, and pipeline and tank-truck terminals.

Tank trucks and tank cars. Tank trucks and railroad cars provide a role in the onshore end of the petroleum transportation system, particularly when volumes for transport are reduced. Tank trucks are the major means of transporting oil products from plants to consumers.

New Technologies—New Product Development

The technological advancements of offshore oil and gas are dramatically illustrated by the changes since the early offshore production in Summerland, California in the 1880s (Figure 3.49). Advances promise the ability to find oil and gas more effectively, to produce in regions once impossible, and to do it all with less interference or damage to the

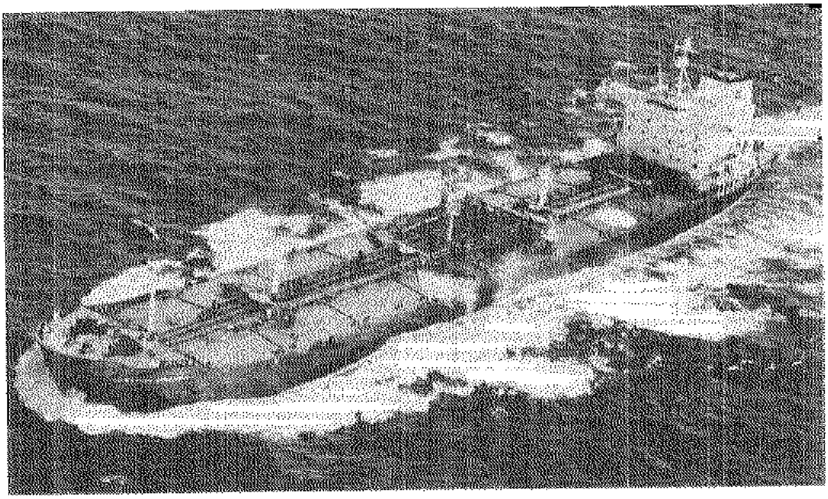


Figure 3.48 Double Skin Tanker. *Chevron Oregon*. (Photo: Chevron Shipping)

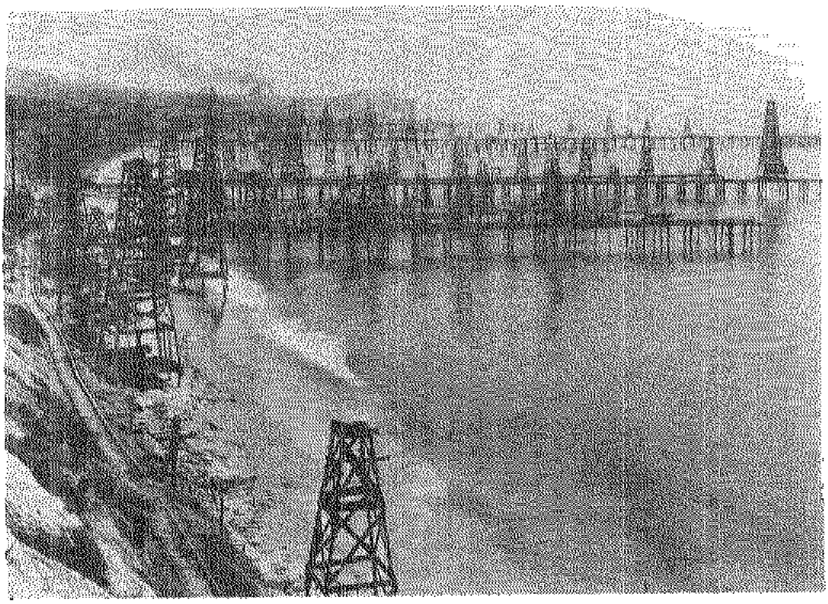


Figure 3.49 Summerland Oil Field, Santa Barbara County, California, circa 1901-04. During the early offshore oil and gas development near Summerland, wells were drilled from piers extending as far as 1,230 feet into the ocean. Approximately 400 wells were drilled in this manner, with some producing from as deep as 600 feet below sea level. Since then, this field has been closed and the coastline restored. (Photo: California Historical Society)

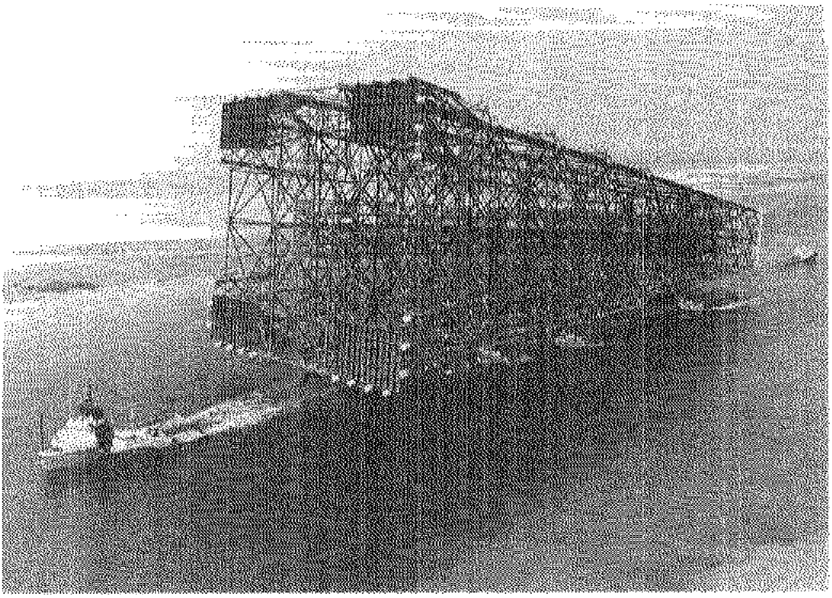


Figure 3.50 Bullwinkle Jacket. This platform jacket was towed from Corpus Christi, Texas to the installation site in the Gulf of Mexico 150 miles southwest of New Orleans. Two years of planning and design and three years of construction were required to complete this 50,000-ton jacket. Installation was completed in October 1988, and production is expected to occur in 1991. (Photo: Shell Offshore)

environment. In its quest to produce profitably more oil and gas, industry continues to innovate:

- One example is the trend toward deep-water drilling. Both exploration drilling and production are reaching greater depths. In 1983, the deepest water depth that a well was drilled was 1,657 feet. In February of 1988, Shell drilled a well in 7,638 feet of water.

- Subsea completions allow production on the sea floor, with the wellheads below the water's surface. Lines then carry the commodity to surface systems for separation, treatment, and storage. A well off the coast of Brazil created a world water depth record for subsea completion and for production when it was completed in 1988 in 1,614 feet of water. Placid Oil Co. anticipates setting a world water depth completion record of 2,243 feet in the Gulf of Mexico as this report is written. Subsea completions bring more deepwater, marginal fields within reach of development.

- Shell Offshore Inc. has recently installed the world's largest oil platform jacket, Bullwinkle, in 1,350 feet of water in the Gulf of Mexico about 150 miles southwest of New Orleans (Figure 3.50). The platform stands 1,615 feet from the sea floor (Figure 3.51).

- Another method of producing oil is to develop small fields using an exploration rig and an OS&T vessel, without ever installing a permanent production structure. This technique may make production economically feasible in situations that are not so with a platform, because leasing an exploration rig costs far less than building a steel-jacketed platform.

- Unmanned production platforms are becoming more common in the Gulf of Mexico. In the North Sea, Amoco (UK) Exploration Co. has decided a cost-effective solution to develop the small

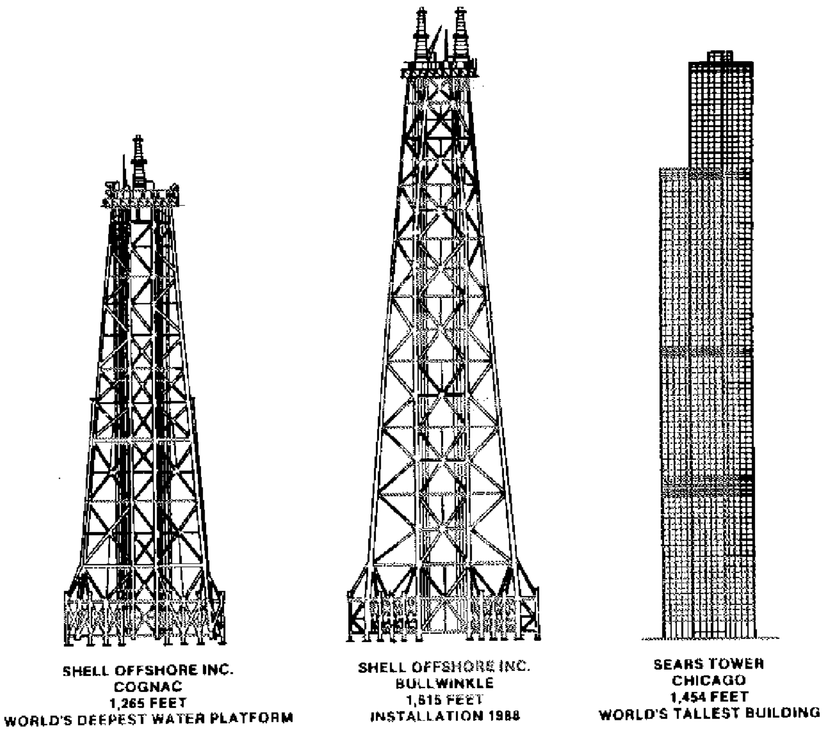


Figure 3.51 Bullwinkle, the World's Tallest Offshore Platform. Bullwinkle's water depth breaks the previous world record for this type of structure held by another Shell platform—Cognac—also located in the Gulf of Mexico, and it is 161 feet taller than the Sears Tower, the world's tallest building. (Source: Shell Offshore)

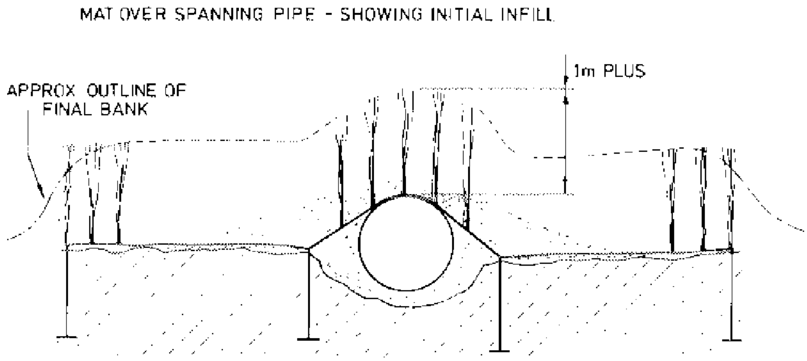


Figure 3.52 New Pipeline Burial Technique. Conventional methods for burying undersea pipelines include digging a trench and letting natural processes fill it in over time (see Figure 3.43) or covering the pipeline with sandbags or rock. These methods may interfere with bottom trawl fisheries. A new technique attempts to stabilize the bottom and pipeline more rapidly, reduce conflicts with other ocean bottom users, and increase pipeline safety. Polypropylene mats with meter-long, grass-like "fronds" are laid over the line to trap sediments, which then build up and cover the line in more natural contours. (Source: Seabed Scour Control Systems)

Arbroath field, 130 miles east of Scotland, is to install a slim-line, satellite platform. The unmanned drilling platform will tie back to an existing integrated drilling and production platform, making use of spare process capacity.

- Minimal platforms, typically of lightweight tripods that rely on the drive pipe/caisson for structural support, are gaining popularity in 30-300 feet of water in calm-weather regions. They make production feasible in certain fields that might not otherwise be economical.

- Sedco Forex is designing a "Development Drilling Semisubmersible" that can drill two wells as well as receive production from as many as 40 completed wells simultaneously. A simplified high-strength mooring system will allow the DDS to drill in water depths up to 6,000 feet without dynamic positioning. Under the right conditions, this system could drill its own relief well.

- As production moves into deeper and deeper water, pipeline installation must also move deeper. McDermott International will install a 7.5-mile oil export pipeline from Shell's Bullwinkle platform, in 1,353 feet of water, to an existing platform. The Gulf's first tension leg platform, which Conoco plans to install in 1,760 feet of water in the Gulf during 1989, is another deepwater pipeline challenge.

- British-developed Scour Control, a mat of polypropylene fronds, promises to reduce "scouring" or erosion around undersea structures like platform legs, and may protect subsea pipelines while reducing interference with bottom fishing (Figure 3.52).

- Sweetening of sour gas on offshore platforms would eliminate the risk to human health from potential leakage along a pipeline route to an onshore separation and treatment facility. UNOCAL has a sweetening unit on a platform off California.

- Horizontal wells are becoming more common. The first to be drilled and tested from a semisubmersible rig in the U.K. North Sea was completed in 1988. The *Sedco 700* did the work in 360 feet of water, and the total length of the hole included a 1,853-ft. horizontal section. This extended reach capability gives the industry improved appraisal of reservoirs, better production from a field, increased flexibility in the siting of platforms, fewer wells and platforms, and more environmental protection.

ENDNOTES

[1]The Department of Interior refers to four classifications of OCS oil and gas potential: (1) *Undiscovered economically recoverable resources*, which are resources, outside of known fields, estimated to exist in potential commercial accumulations based on geologic, engineering, and economic inferences; (2) *Measured reserves*, which are proved reserves in known fields; (3) *Indicated reserves*, which are additional quantities of hydrocarbons in known reservoirs, believed to be economically recoverable using enhanced recovery techniques; and (4) *Inferred reserves*, which are quantities of oil and gas in known fields, which may be found by further drilling.

[2] U.S. Department of Interior, Minerals Management Service. *Pacific Summary/Index: June 1, 1986—July 31, 1987*. Vienna, Virginia, OCS Information Program, p.11.

[3] A highly readable account of life on a North Sea offshore oil platform was written by A. Alvarez, "A Reporter at Large," and published in the 27 January 1986 issue of *The New Yorker*, p. 34 and following.

[4] Kennedy, John L. *Fundamentals of Drilling: Technology and Economics*. PennWell Publishing Co., Tulsa, OK, 1983, p. 167-169.

4

Case Study Scenarios

Upon learning that the offshore oil and gas industry might someday operate in OCS waters off the Washington coast, it is natural to imagine how things would look and become. To promote cohesive, consistent visualizations by individual Committee members and provide a common framework for analysis, two case scenarios were developed for study:

Case 1	Dry, Sweet Gas Company
Case 2	Light, Sweet Oil Company

Each case was subdivided by phases (omitting leasing and shutdown):

1. Dry, Sweet Gas Company:
   - Case 1-A Exploration
   - Case 1-B Development and Production

2. Light, Sweet Oil Company:
   - Case 2-A Exploration
   - Case 2-B Development and Production

These cases were intended to trigger the imagination and stimulate discussion among the ORAP Advisory Committee members. In content, the scenarios were meant to be reasonable for purposes of study. That is, in general, they should be interesting and technically and economically feasible but not the best- or worst-case options. The case scenarios are neither forecasts nor projections and are deliberately not all-inclusive or site-specific. Some assumptions and information were purposely omitted.

The test for whether the scenarios are well-defined cases is this: Did they elicit good questions and therefore useful answers about information gaps and research needs concerning potential offshore oil and gas exploration, development, and production off Washington?

The scenarios are first presented as they were accepted and used by the Advisory Committee. During the course of the study, the subcommittees discovered additional detail as they investigated their respective subject areas. Refinements emerged as the result of what the subcommittees learned from their task-oriented meetings, readings, and trips. Committee members' ideas of embellishments, changes, or implications for Washington state are discussed at the end of this chapter.

Cases 1A-B: Dry, Sweet Gas Company

CASE 1A: EXPLORATION

The Dry, Sweet Gas Company, which owns and operates one of the four oil refineries in the northern Puget Sound region, is the successful bidder in a lease sale on several contiguous tracts in federal waters located more than 12 miles west of Grays Harbor, Washington.

DSG Co. first conducts "preliminary activities," and then submits its Exploration Plan to MMS, describing the proposed offshore operations. It plans to contract with a seismic surveying company for seismic operations and with an offshore drilling company for a semisubmersible rig to conduct the test drilling. The plan is accompanied by an oil spill contingency plan and an environmental report (ER). Support operations will be conducted from within existing developed harbors.

Having operated in Washington for many years, DSG Co. is both well known by elected officials and government entities and generally understands state natural resource and environmental policies, regulations, and procedures. This is the first lease sale here since 1964, however, and would be the first exploratory drilling off the state since 1967. It is difficult to assess what the Governor's comments on the Exploration Plan will be and whether the state will concur with DSG Co.'s coastal zone management consistency certification.

Meanwhile, DSG Co. prepares to submit its Application for Permit to Drill (APD), explaining in detail its planned drilling program, including the blowout-prevention system and the casing, cementing, and drilling-mud programs.

There are concerns by some that the information in the plans is inadequate for making a good decision about CZM consistency. In particular, the county raises many questions, and Indian tribes ask for more information. DSG Co. moves quickly to respond, and eventually the Exploration Plan and APDs are approved, with permit conditions, by MMS.

One year later, after drilling only three unsuccessful wells, DSG Co. discovers natural gas below one of its leased tracts. The well is about 15 miles off the mouth of Grays Harbor in water depths of about 90 meters.

More seismic surveys follow. DSG Co. drills enough delineation wells to determine the extent of the field within its adjacent lease tracts. The gas is dry and sweet—it contains no dissolved liquids and no hydrogen sulfide gas.

CASE 1B: DEVELOPMENT AND PRODUCTION

Proven, indicated, and inferred reserves appear sufficient to sustain extraction for approximately 20 years at reasonable production rates for the projected prices of gas during the lifetime of the field. The local gas utility company serving the Aberdeen/Hoquiam area is willing to enter into a contract to purchase some of the gas. Also, there is a chemical company that would like to build a fertilizer plant in southwestern Washington and sell urea to the agriculture industry in eastern Washington and Oregon. This company believes it can beat the price of fertilizers being shipped up the Columbia River from California and Alaska. Finally, DSG Co. would like to have this alternate source of supply for its northern Puget Sound refinery in case Canadian natural gas becomes unavailable or too expensive in the future.

Having completed its internal business planning, DSG Co. works out its Development and Production Plan and submits it to MMS and thereby to the State of Washington. Initially, one platform is planned, from which 15 to 20 wells will be drilled. A pipeline (inside diameter greater than 14 inches) will transship the dry, sweet natural gas more than 15 miles, where it will connect on land with a main transmission pipeline that is owned by the gas utility company. Gas will be delivered to the fertilizer company's nearby plant via a spur pipeline from the transmission line. Ashore, there will be a marine terminal designed for tug and barge, supply boat, and crew boat berthing and operations. A helicopter pad will be built on site. There is sufficient yard space at the site to support most routine operations during the production phase, but heavy-lift cranes will be needed somewhere to handle some big equipment at certain times during both the development and production phases.

DSG Co. is informed that a site-specific EIS will be required by MMS because this is the first significant development proposed for this leasing area. The State of Washington also requires an EIS, and there is talk that perhaps the two processes should be combined to avoid unnecessary duplication and inconsistent or untimely decisions. Moreover, coastal Indian tribes say they will go to federal court to prevent any more exploration, development, or production.

DSG Co. needs a better sense of the potential consequences of these eventualities before taking a position and supporting it within the various levels of government and among special interest groups and the general public.

Foremost is its concern about what information already exists and what new information will have to be generated through future research in order to obtain permission to produce the gas. DSG Co. has a lot to learn and do quickly.

CASES 2A-B: LIGHT, SWEET OIL COMPANY

CASE 2A: EXPLORATION

One day, Washington state receives from Minerals Management Service (MMS) a copy of the Exploration Plan submitted by the Light, Sweet Oil Company. The plan requests approval to begin test drilling for petroleum within several contiguous tracts in federal waters located more than 12 miles west of Grays Harbor, Washington. LSO Co. successfully bid on these tracts in a recent lease sale. Accompanying the plan are two other documents: the oil spill contingency plan and an environmental report (ER).

MMS has 30 days to approve or disapprove the plan, and the Governor expects to submit written comments in time for MMS to consider them in its technical and environmental evaluation. Also, if the state objects to LSO Co.'s Coastal Zone Management consistency certification, it will so notify MMS in less than three months.

LSO Co. has no refineries or gas processing plants in Washington but is a major refiner in the greater San Francisco Bay and Los Angeles areas. It transports refined products by tug and barge and product tankers from California to Puget Sound, where it operates a marine terminal and storage facilities. The state is familiar with LSO Co.'s operations, performance record, and reputation.

The company plans to contract with a seismic surveying firm for seismic operations and with an offshore drilling firm for a semisubmersible rig to conduct test drilling. While MMS, the state, and others review the Exploration Plan, LSO prepares to submit its Applications for Permit to Drill (APD), explaining in detail its planned drilling program, including blowout-prevention system and the casing, cementing, and drilling-mud programs.

There are concerns by some that the information in the Exploration Plan, oil spill contingency plan, and ER is inadequate for making a good decision about CZM consistency. In particular, the county raises many questions, and Indian tribes ask for more information. Eventually, the Exploration Plan and APDs are approved, with permit conditions, by MMS.

One year later, after drilling only four unsuccessful wells, LSO Co. discovers oil and gas below one of its leased tracts. The well is about 15 miles off the mouth of Grays Harbor, in water depths of about 90 meters.

More seismic surveys follow. LSO Co. drills enough delineation wells to determine the extent of the field within its adjacent lease tracts. The gas is wet (combined with dissolved liquids) but sweet (containing no hydrogen sulfide gas). The oil is light (39° API), paraffinic, and sweet.

CASE 2-B: DEVELOPMENT AND PRODUCTION

Within 60 days, the Governor must submit to MMS his comments on the Development and Production plan submitted by LSO Co. MMS will consider the comments in its technical and environmental evaluation of the plan, which is accompanied by an oil spill contingency plan and an environmental report (ER). The Governor may urge MMS to require an EIS, since this is only the second OCS development proposed off Washington and the first involving oil as well as natural gas.

Also, if the state objects to LSO Co.'s CZM consistency certification, it will so notify MMS within three months.

According to the Development and Production plan, one platform is planned, from which 25 to 30 wells will be drilled. A crude oil pipeline (inside diameter greater than 14 inches) and a gas pipeline (inside diameter less than 14 inches) will transship the sweet commodities more than 15 miles to an onshore tank farm and a separation and treatment facility. These facilities will be co-located with a marine terminal designed for tanker, tug and barge, supply boat, and crew boat berthing and operations. A helicopter pad will be built on site. There is sufficient yard space at the site to support most routine operations during the production phase, but heavy-lift cranes will be needed somewhere to handle some big equipment at certain times during both the development and production phases.

The state learns that the methane gas will be sold to the local gas utility company serving the Aberdeen/Hoquiam area, which wants to expand its market area throughout southwestern Washington. Liquefied petroleum gas (principally, butane and propane) will be transshipped by refrigerated tankers to various markets. Most of the crude oil will be loaded aboard tankers bound for LSO Co.'s refineries in California. However, since LSO Co. expects to make occasional sales to and exchanges with the four companies which have refineries in northern Puget Sound, marine shipments to Anacortes and Ferndale terminals are anticipated.

The state feels the amount of information is too sparse and the level of uncertainty is too high. Under its own legal powers, the state decides to require a site-specific EIS. There is talk that if MMS requires one also, the two processes should be combined to avoid unnecessary duplication and inconsistent or untimely decisions. Moreover, Indian tribes say they will go to federal court to prevent any more exploration, development, or production.

The state needs a better sense of the potential consequences of these eventualities. Additional information would help, and the sooner, the better.

EMBELLISHMENTS

As stated above, these cases are skeletal. Various embellishments can be made on this framework. An example, developed by one Committee member for consideration by all, follows.

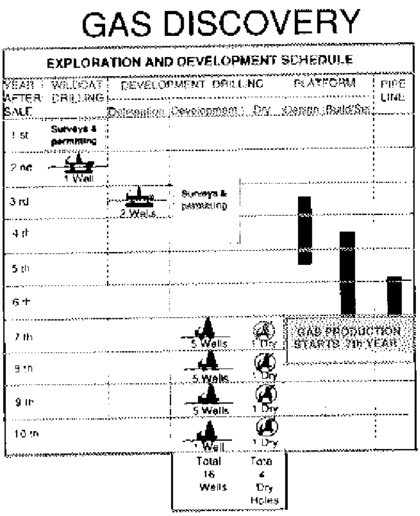
EXPLORATION, DEVELOPMENT, AND PRODUCTION SCHEDULES

First, life cycle runouts of both cases were made, assuming first quarter 1988 prices throughout.

Cases 1A-B (Dry, Sweet Gas Co.). DSG Co. drills three wells to find and delineate the gas field (Figure 4.1). Then the company designs, builds, and installs one platform and runs a pipeline ashore, as described in the case. Next, it drills 20 wells during a 4-year period. From the platform, DSG Co. continuously drills 6 wells per year during years 7 through 10. Sixteen of these produce gas, and four are dry holes.

Figure 4.2 shows production starting in year 7, and as each new producing well comes on-stream, production increases from 3.2 billion cubic feet to 15.9 in the peak year 10. Thereafter, the field starts its period of decline. Gas production ends after 25 years of production, which is 31 years after the lease sale. This does not mean there is no more gas in the ground; rather it means that it would no longer be economic (at 1988 prices) to produce the gas, given the assumptions of the model. This runout assumes primary recovery only (no secondary or tertiary recovery) and built-in pressure maintenance; also, it is based on a uniform rate of decline. By the end, almost 253 billion cubic feet of gas would have been produced under this scenario.

Cases 2A-B (Light, Sweet Oil Company). LSO Co. drills five wells to find and delineate the oil and gas field (Figure 4.3). Then the company designs, builds, and installs one platform and runs an oil pipeline and a gas pipeline ashore, as described in the case. Next, it drills 40 wells during a 7-year period. From the platform, LSO Co. continuously drills 7 wells per year for years 8 and 9, six wells per year for years 10 through 13, and two for year 14. Thirty-two of these wells produce oil and gas, and 8 are dry holes.



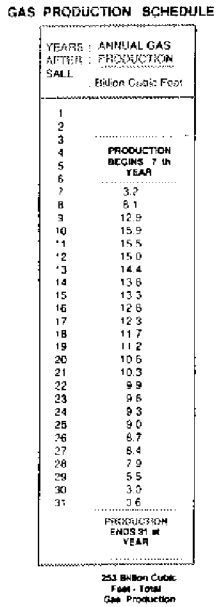
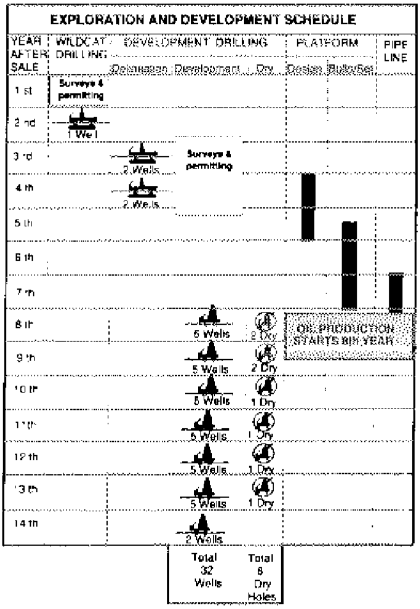


Figure 4.1 Left, Typical Exploration and Development Schedule Following Gas Discovery. Note construction "boom" period, if any, during years 4-6 for the assumed conditions. (Source: H.F. Hazel, Chevron USA)

Figure 4.2 Right, Typical Gas Production Schedule. Note peak year 10, when last of 16 wells starts production under assumed conditions. (Source: H.F. Hazel, Chevron USA)

OIL & GAS DISCOVERY



OIL PRODUCTION SCHEDULE

YEARS AFTER SALE	ANNUAL OIL PRODUCTION (Millions of Barrels)	ASSOCIATED ANNUAL GAS PRODUCTION (Billion Cubic Feet)
1		
2		
3		
4		
5		
6	PRODUCTION BEGINS 8th YEAR	
7		
8	2.8	5.6
9	6.4	12.8
10	8.7	17.4
11	10.3	20.6
12	11.5	23.0
13	12.4	24.8
14	12.3	24.6
15	8.9	17.8
16	6.5	13.0
17	4.8	9.6
18	3.7	7.4
19	2.9	5.8
20	2.3	4.6
21	1.9	3.8
22	1.5	3.0
23	1.3	2.6
24	1.0	2.0
25	0.8	1.6
26	0.6	1.2
27	0.4	0.8
28	0.2	0.4
	PRODUCTION ENDS 28th YEAR	
	100 Million Barrels - Total Produced Oil	200 Billion Cubic Feet - Total Associated Gas

Figure 4.3 Left, Typical Exploration and Development Schedule Following Oil and Gas Discovery. Note construction "boom" period, if any, during years 5-7 for the assumed conditions. (Source: H.F. Hazel, Chevron USA)

Figure 4.4 Right, Typical Oil and Gas Production Schedule. Note peak year 13 for the assumed conditions. (Source: H.F. Hazel, Chevron USA)

As Figure 4.4 indicates, production starts in year 8 and peaks in year 13, and declines thereafter through year 28, when the model says it would no longer be economic (at 1988 prices) to continue production. Again, the model assumes uniform decline, built-in pressure maintenance, and primary recovery methods only. By the end, 100 million barrels of crude oil and 200 billion cubic feet of associated gas would have been produced. Production stops after 21 years, which would occur 28 years after the lease sale.

Further Embellishments

It would be comparatively simple for a balanced, interdisciplinary group to build further on these cases for subsequent studies. This research method of study is quite common and is in use in at least two current studies at the state and county level in California, studying offshore oil and gas developments there.

In Washington, it has been suggested, for example, that fiscal impacts could be investigated if the scenarios included assumptions about capital investment, jobs, payroll, and procurement. With further embellishments, even more socio-economic (including cultural) impacts could be investigated.

Additional assumptions could be made about blowouts, fires, spills, control and cleanup responses, and restarts for purposes of examining accident causes and potential consequences, along with prevention and mitigation techniques.

COMMENTARY

As the case studies were contemplated, several comments were reported and discussed. First, the size and length of the pipelines are significant in terms of the state energy facility siting process. In Case 1-B, the inside diameter of the gas pipeline is more than 14 inches. In Case 2-B, that of the crude oil pipeline is greater than 14 inches, while that of the gas pipeline is less than 14 inches. This prompted discussion about the threshold limits for jurisdiction of the Energy Facility Site Evaluation Council (EFSEC), which, for (a) crude or refined petroleum or liquid product transmission pipelines, is defined as:

> larger than six inches inside diameter between valves for the transmission of these products with a total length of at least fifteen miles,

and for (b) natural gas, synthetic fuel gas, or liquefied petroleum gas transmission pipelines, is stated as:

> larger than fourteen inches minimum inside diameter between valves, for the transmission of these products, with a total length of at least fifteen miles for the purposes of delivering gas to a distribution facility, except an interstate natural gas pipeline regulated by the United States federal power commission.

It was noted that in both Case 1-B and 2-B, the total lengths of the pipelines are more than 15 miles. While it was not anticipated that these would be interstate, common-carrier pipelines, there was comment about a potential case where the platform might be off the Oregon side of the Columbia River mouth but be connected by underwater and overland pipeline to an onshore processing plant or marine terminal in Washington--or vice versa. Questions were raised about whether the EFSEC process would apply regardless of whether the entire 15 miles were within Washington boundaries and jurisdiction; for example, if 10 miles of the pipeline were within federal waters under MMS jurisdiction but six miles were inside the three-mile territorial sea and on Washington land, would EFSEC apply?

This line of commentary led to the broader consideration of whether the EFSEC threshold limits are appropriate to the offshore oil and gas industry, since this industry apparently was not foremost in the minds of the legislature at the time EFSEC was created. Do—or should—the current definitions of "energy plant" and "associated facilities," for example, cover oil and gas separation and treatment plants? And should any proposed offshore platform in state waters, regardless of throughput or pipeline size and length, come under the EFSEC process? Or if thresholds are to be retained, are there more appropriate parameters for triggering the EFSEC process?

Second, Case 1-B was found to be ideal in that the gas is completely dry—an unlikely condition, especially over the life cycle of a producing field. It is perhaps unrealistic to anticipate that a pipeline from the offshore platform could hook up directly on land, with only an odorizing unit added, to a main transmission pipeline that is owned by a gas utility company. Some type of separation and treatment, either offshore or onshore, is probable before the gas could be sold to such a company.

Third, in Case 2-B, there are two statements to the effect that if the state objects to LSO Co.'s Coastal Zone Management consistency certification, it will so notify MMS within 3 months. For clarification, this notification is an interim step, and the state CZM agency actually has up to 6 months to act on the Exploration Plan's and the Development and Production Plan's consistency certification.

Fourth, an obvious alternative to the onshore separation and treatment plant in Case 1-B would be an offshore storage and treatment plant outside the 3-mile state waters. Among the possible reasons for such a plant could be the desire to avoid onerous permit conditions that might be imposed by local or state governments if the plant were to be located onshore.

Fifth, the natural properties of the gas and crude oil, as identified in the Exploration Phase, were recognized for their critical roles in determining the kinds of facilities, equipment, processes, operations, and impacts that eventually would result during the Development and Production phases. Once identified, variables such as "sweet, sour, dry, wet, light, heavy, paraffinic," and more are harbingers of the potential economic feasibility of and the environmental impacts from producing the discovered oil and gas. For example, if sour, then there are risks from the poisonous gas, hydrogen sulfide, which must be managed both in facility design and operations; if wet, then separation and treatment will produce by-products or wastes that must be managed; if heavy, then most of the refined products are likely to be asphaltic and more prone to transportation by truck than vessel, implying a reduced level of risk of spillage from oil product tankers and barges; and if highly paraffinic, heating might be necessary under certain cold conditions; and so forth.

Sixth, the development of an ammonia/urea fertilizer plant in Washington, as postulated in Case 1-B, was considered unlikely.

5

Information Demands, Gaps, and Needs

Since Washington state currently has no offshore petroleum operations, the beginning of such activities will affect a multitude of existing natural, social, and economic systems. Because of the complex interactions and interdependencies, changes to these systems not only will have primary impacts, but secondary and tertiary effects as well.

The key to dealing effectively with potential impacts lies in (1) understanding the dynamics of the existing system—the inputs, outputs and cause-effect relationships among the system components, and (2) understanding the changes that will be made. If the causal relationships are understood and the anticipated changes are identified, then the probable impacts of those changes can be better anticipated.

Any existing system is not static. It is perpetually changing. A system may be a steady-state, with no net changes, but it is more apt to be evolving or moving. Thus changes to a system, for example, by introducing a new industry, must be examined in this dynamic context.

System changes may be positive, negative, or neutral. They may affect many or few parts of a system and their impacts may be beneficial, damaging, or insignificant. In fact an impact may be viewed as beneficial by some but as adverse by others.

Analyzing systems requires (1) knowledge of the systems and their dynamics (the system components and their causal relationships) and (2) information about potential changes. For Lease Sale 132, that means understanding and analyzing (1) the existing natural and socio-economic systems in Washington and (2) the changes that may be caused by developing an offshore oil and gas industry in the state. Such analysis is necessary for the state to participate effectively with the federal government and the oil industry in the decision-making process.

From their own diverse background, their intensive study of offshore oil and gas and related issues, and their discussions with many people experienced in dealing with offshore oil and gas issues, Committee members have identified areas of concern or interest, which are called *information demands*. Essentially, information demands include the base of knowledge about the existing systems: information about components of existing systems, about the relationships or dynamics among those components, about the new industry, or about how similar changes impacted other areas where the offshore oil and gas industry operates.

Based on what they learned and what experts recommended, Committee members developed a sense of where such information is probably adequate and where it is probably inadequate or not applicable to Washington, thus identifying *information gaps*. Finally, Committee members, acting as diverse, informed representatives of the people in the state, identified what they, at this time, believe to be the information priorities for Washington state, or the *research needs*. The research needs are mentioned in this chapter, but are most directly addressed in Chapter 6.

This report uses five categories to assess this information:

- **Environment** includes impacts on the environment or existing resources—how they may affect or be affected by oil and gas exploration, development, and production. Most topics in this category concern natural systems.

- **Use Conflicts** occur if petroleum activities enhance, interfere with, or exclude other existing or potential activities in the same area. The interference could ultimately have positive or negative impacts, raising questions of space problems or incompatibility. While use conflicts may involve environmental resources (such as fish), this category emphasizes human uses of those resources (such as recreational or commercial fishing).

- **Community Decision-Making** (government) refers to the impacts on and responses required of all organized groups, ranging from local governments to Indian tribes to state government. It includes questions on organization and coordination that arise from siting, permitting, operating, monitoring, and enforcing. Community decision-making impacts are part of the socio-economic system.

- **Personal and Interpersonal** impacts include those that affect individuals or that affect relationships among individuals. As such, economic impacts fall under this category as well as under community decision-making. Aesthetic changes and changes in feelings, motivations, goodwill, or animosity among people are among personal and interpersonal impacts. Personal and interpersonal impacts belong, for the most part, in the socio-economic system.

- **Safety and Risk** (actual and perceived) are considered separately even though they interrelate with all four categories above. Safety and risk are an integral part of both the natural and socio-economic systems.

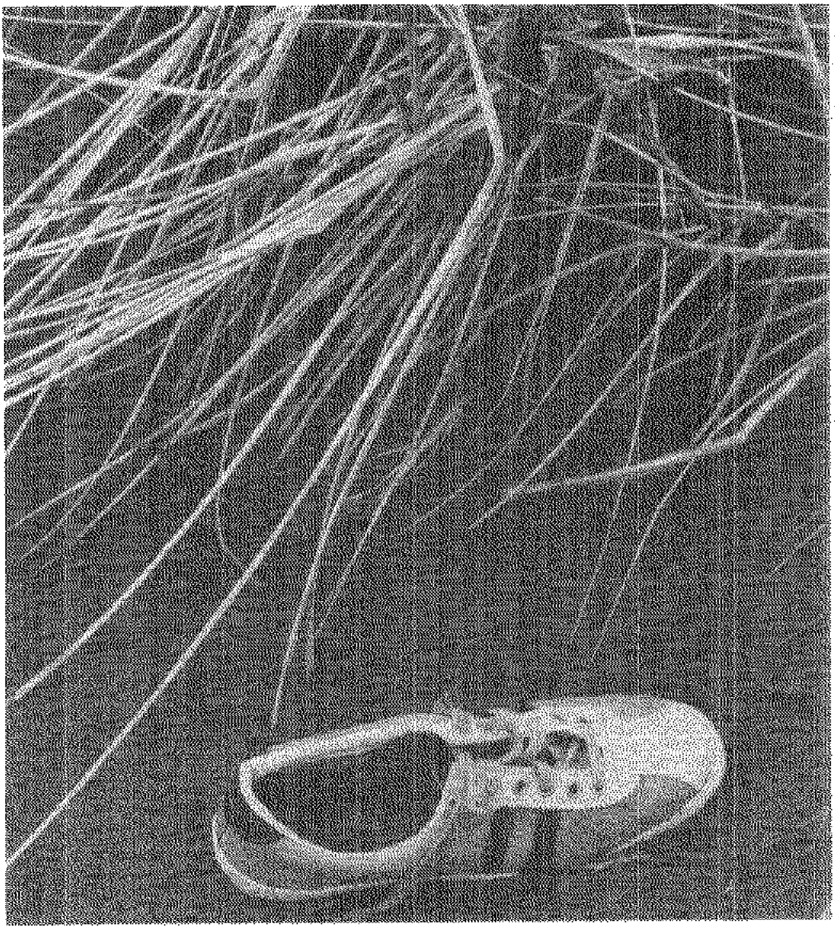


Figure 5.1 On the Beach. Washington coast, where man is part of the ecosystem. (Photo: Robert F. Goodwin, WSG)

None of these categories is mutually exclusive. Certain subjects, such as aesthetics, apply to more than one category. There are areas of overlap among these categories, just as there is overlap between natural and socio-economic systems.

To make these assessments, the ORAP Advisory Committee used the hypothetical case scenarios described in Chapter 4 to exercise members' imaginations and prompt investigative questions. Committee members also gathered information from other regions of the country that have experienced OCS activity. By considering hypothetical cases and studying real examples of offshore exploration, development, and production, Committee members identified information concerns relevant to post-lease phases of oil and gas development. The knowledge generated allowed the Committee to consider implications for the pre-lease stage as well, and these are discussed at the end of this chapter.

These examples and the concerns identified are *tools* to help in decision making: they are not designed to convince the reader that offshore oil and gas development should or should not occur.

POST-LEASE STAGE

The information demands, gaps, and research needs of post-lease offshore oil and gas development vary during the different phases of development, so the Committee considered what information was needed during the exploration, development, and production phases of offshore oil and gas. The discussion of each category begins with a description of pertinent aspects of existing systems. Committee insights follow, including brief discussions about possible changes to the existing systems and anticipated impacts—what is known or not known—information demands and gaps.

EXPLORATION PHASE INFORMATION DEMANDS AND GAPS

Since offshore oil and gas exploration is a temporary phase, leading only into possible development, most of its impacts are limited in time. Because onshore activities are minimal during exploration, direct or primary impacts, with the exception of oil spills, lie offshore.

Environment

Environment is a very broad category. Environmental systems have been studied intensively over the years, yet much is unknown about earth sciences, atmospheric sciences, oceanographic sciences, life sciences, about natural cycles, and so forth. Even less is known about the interdependence of these different subsystems. For example, that an organism needs water, and how it gets water, may well be understood. Certain changes in ocean characteristics are understood; others, such as El Niño events, are not. Many questions remain unanswered. How much change, of what kinds, can ocean water withstand before the quality begins to affect adult fish, or fish eggs, or animal larvae?

Obviously, the more complicated the system dynamics, the less is clearly understood. For example, consider how an El Niño event might affect reproduction of or food availability for the Dungeness crab. Then add to the complexity: What would be the effect on the Dungeness crab food supply if there is discharge of drilling fluids from exploratory wells during an El Niño?

Because the volume of information required to understand fully the environment (or comparable systems) is immense, only selected topics of major importance are addressed here. Committee members noted the following areas where information is not sufficient to understand either the existing systems in Washington or the anticipated changes that might be expected if exploration for offshore oil and gas occurs.

Fish and Wildlife. Most knowledge about the offshore fish and wildlife resources of Washington centers on commercially harvested species. The state of knowledge may consist of little more than pounds of fish landed. The seasonal distribution and abundance of many species are unknown, as are the feeding and breeding areas. Often critical ecological relationships for common species are not understood.

In Washington, there are concerns that seismic testing will harm fish or larval forms of other animals, such as crabs and razor clams. Seismic testing may make fish scatter and go "off the bite." Of particular concern are questions of how such interruptions might affect migrating salmonids, tribal allocations of salmonids, and catch per unit of effort (CPUE).

A number of studies currently underway may be relevant to Northwest fish resources. These include a study of the effects of seismic air-gun surveys on Dungeness crab eggs and larvae, with a follow-on study proposed. A similar study on anchovies also has been done. Moreover, MMS has funded work on the effects of air guns on the behavior of rock fish and a follow-up study is being procured at this writing.

Although the impacts of exploratory drilling normally are fewer and less significant than those of production drilling, there are still concerns about the potential vulnerability of Washington's coastal fish and wildlife resources to impact from oil spills and disposal of drilling muds and cuttings.

Topics of interest relative to fish and wildlife resources include identifying the offshore marine habitats and seasons that are critical for feeding, breeding, and migration for fish, marine mammals, and birds. It is equally important to identify the critical coastal habitats and seasons that may be particularly vulnerable to oil spills. Such background information is essential to anticipate impacts, devise mitigation methods, and monitor activities. Monitoring must be able to accurately attribute impacts and apportion impact funds.

Oceanography. Knowledge of wind, wave, current, and upwelling patterns will help identify the times that might be optimal for exploratory drilling in order to minimize damage from potential oil spills.

Use Conflicts

The ocean holds immense resources that are currently used by people in a variety of ways. The waters are used for shipping, for commercial and recreational fishing, for aquaculture, for military and defense purposes, for scientific research, and for recreation, from sightseeing to boating to diving. Already there are conflicts among users: towboats and steamships; sport fishing, commercial fishing, and tribal fishing compete

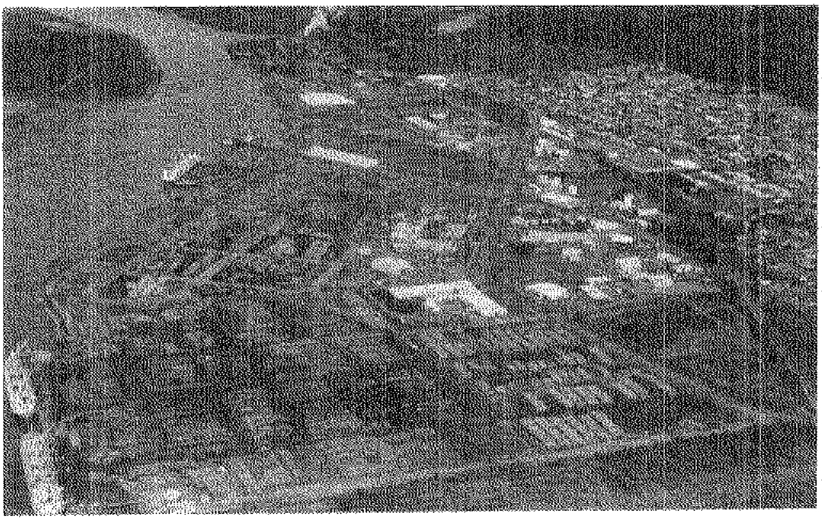


Figure 5.2 Vessel Traffic in Grays Harbor. In 1987, a total of 243 commercial vessels called at public and private terminals in Grays Harbor—36 were tankers and barges, carrying oil and lignin liquids (by-products of the pulping process), and 207 were logships in export trade with PacRim countries and Turkey. Of the 207 logships, 153 (74%) had drafts greater than 30 feet. Many of the ships were handled at the Port of Grays Harbor, shown here. (Photo: Jones Photo Co., Aberdeen, Washington)

for the same space, the same resources, often at the same times. There is some resolution, and basic problems of coexistence have been worked out among current users. But there are still some problems, and seismic exploration and offshore oil, as new, temporary users, would add to them. Thus, offshore oil and gas would not be diving into a clear, calm pool—the waters already are choppy, if not stormy. There are conflicts now, and forces for change. Oil and gas simply complicates an already complex system.

Fishing. Perhaps the biggest space-use conflict a new offshore oil and gas industry would encounter is with the recreational and commercial fishing industries.

Based on Washington's early experience in the mid-1960s and on California's and Alaska's recent experiences, real problems are likely to arise immediately between exploration and fisheries. Memories are long, and Washington fishermen's animosity to seismic operations has persisted, even though it has been more than 20 years since drilling occurred off the Washington coast. The relationship of the oil industry to commercial and recreational fishing in California should be studied for techniques of conflict resolution and mitigation to aid in defusing conflicts.

A variety of recreational and commercial fishing operations depend on the resources off the Washington coast.[5] In addition to the mobile fishing activities (trolling, trawling, etc.) there are a number of fixed gear fisheries (pot fisheries for Dungeness crab and sablefish, tribal set-net fishing, long-line gear for sablefish, etc.). Coastal bays and estuaries are sites of major shellfish culture activities for the Pacific oyster as well as hardshell clams. These fisheries support a major portion of the coastal economy.

Seismic survey boats may interfere with fishing boats and equipment or impact target species. Operating seismic vessels tow streamers about two-miles long that impede maneuverability. Drift fishermen and fishermen with set equipment may compete with seismic vessels for the use of fishing areas. Concerns remain that seismic surveys or consequences of exploratory drilling, ranging from drilling discharges to potential oil spills, may impact harvestable fishery resources.

Studies currently underway include work funded by the MMS to summarize and, to the extent possible, standardize certain fisheries catch information (see Appendix E). The intention is to computerize and map the information for use in environmental planning and assessment.

Assessment of the current situation and analysis of probable impacts as well as development of protective measures are all potential topics for study, including the possibility of setting seasons or "windows" for seismic activity, when conflict with certain fisheries could be minimized or eliminated. More information is needed about commercial and recreational fishing, fisheries conflict resolution, compensation, socio-economics of fishing conflicts, and effects of drilling discharges on eggs and larvae. (A National Academy of Sciences study panel released a report on the environmental impacts of drilling fluids in 1983.)

Community Decision-Making

The existing system of decision-making could be viewed as layers of reasonably independent subsystems representing each level of government: federal, state, county, municipality, tribal authority, port authority, and so forth. There are complex interrelationships within each subsystem and between each subsystem. The existing decision-making system has many details of authority, process, and communication worked out, but just as significant are those areas where control is not well determined. (Chapter 2 provides some examples.) Conflicts exist between state and federal government, between states, between state and local governments, and between local governments, and between the goals of different government programs within the federal, state, or local level.

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[5] The *Handbook for Geophysical Operators for Washington's Offshore and Inland Marine Waters*, 1986, produced by the Washington Department of Ecology, describes regional commercial fishing gear and methods.

Indian tribes have unique rights, granted by treaty, that are just now being exercised. Tribal fishing rights have been so carefully negotiated that any perturbation could cause serious problems. Offshore oil and gas development should encourage many groups to gather around the discussion table.

Washington state and local government have not previously addressed offshore oil and gas in legislating, regulating, or public planning. Thus many questions exist about how best to organize to identify and meet the many anticipated needs: financial, social, economic, educational, infrastructure, etc.

If a federal lease sale occurs as planned, a wide range of agendas will exist among decision-makers. Currently, the counties along Washington's coast are depressed financially, having suffered from long, severe declines in logging and fisheries. They are especially interested in jobs and in building their economies. Others in the state promote tourism or environmental concerns. In the absence of well planned negotiations, conflicts among interests appear inevitable.

Siting/Permitting/Operating/Monitoring/Enforcement. From the beginning of the exploration phase, state, local, and tribal governments will need to deal with exploration planning and monitoring, then with development planning. To cope effectively, they must have sufficient staffing and expertise to deal with all the questions that arise. Adequate staffing must include sufficient personnel, training, and budget.

Permitting issues loom large as planning begins for the development phase. Decisions for permitting will set precedents for the 30 or more years of production, and must take into account the environmental, socio-economic, and governmental needs to come, as well as monitoring and enforcement capabilities. A first step in this process will be evaluating the adequacy of existing siting and permitting processes at the state and local level.

Since the strongest role the state may have during the exploration phase is in ruling on whether Exploration Plans and (later) Development and Production Plans are consistent with the state's Coastal Zone Management Program, it is important that the Shoreline Master Programs of the four coastal counties be updated to address offshore oil and gas exploration and development. Currently they do not specifically address offshore oil and gas and onshore facilities.

From the experience of other states, in order for permitting, siting, and impact mitigation to be accomplished successfully, there must be an organized joint effort that allows the state, the local governments, affected Indian tribes, residents, and public interest and special interest groups to participate fairly in the federal process.

Other states have found a need for a comprehensive ocean management plan (Oregon) or a comprehensive energy plan, which can then provide a framework for individual decisions on issues such as offshore oil and gas.

Decisions that are framed within the context of a comprehensive plan may be easier to coordinate and enforce.

Jurisdiction. While the division of labor and authority between the state, state agencies, local governments, and Indian tribes may not be clearly established, authority issues make it essential that there be a cooperative, joint process to reach major decisions on siting, permitting, and impact mitigation. All groups must believe they contributed to the decisions made and can support them. Jurisdictional issues are discussed more thoroughly under "Development."

Socio-economics. Socio-economic monitoring, assessment, and projection of potential impacts must begin soon after the lease sale so that any impacts are identified and accurately attributed. State and local agencies in Alaska and California emphasized the importance of requiring the oil and gas industry to pay for its own impacts and services. While socio-economic impacts of exploration are comparatively minor, the process for monitoring impacts and attributing funds must be operational as exploration begins. Calibration and refinement of that monitoring system would occur at future stages of the process.

Another concern during the exploration phase is managing speculation in an effort to prevent a boom/bust phenomenon. In addition to a public education campaign, managing speculation requires zoning and ordinance planning as well as infrastructure and capital improvement planning to limit speculative growth. This is also a good time to begin planning for the needs of the development phase, when construction activities and manpower are at a peak. Local communities can plan how to meet the needs for schools, housing, and emergency management during the peak time and the drop in employment when production begins.

Personal and Interpersonal

Personal and interpersonal issues form what could be called mini-systems in dealing with offshore oil and gas development. Although not easily defined, personal reactions and value judgements will drive the decision-making and may hold great responsibility for outcomes. Attitudes and reactions are in a large part based on past experience, memories, general outlook, and a sense of personal and economic well-being. Is personal income going up or down? Is life easier or harder? Can reasons be identified for changes (either real or perceived)? How will current evaluations affect future decisions?

Offshore oil and gas, as a new industry in Washington, would find that it faces a variety of reactions, from friendliness and hope to animosity and fear. These personal reactions will not be isolated; they will carry over into other systems in the state, changing existing alliances and adversarial relationships and ranging from animosity to eager support.

Offshore oil and gas could force a better understanding of aesthetics, which will be a key issue.

Safety and Risk

Decisions about safety and risk will have consequences for all environmental, community decision-making, and personal and interpersonal systems.

Risk assessment is a quantitative determination of the risk from a specific activity or event (or set of activities). It is calculated from the event's likelihood (probability) and the magnitude of the expected impact. Risk assessment is a scientific means of comparatively evaluating proposed changes in technology and the environment.

However, risk assessment does not always adequately describe how risky an event or activity appears to be to the public. The difference between public perceptions of risk and the scientific assessment of risk grows particularly large when dealing with events that have a low probability of occurring but a big consequence or effect if they do occur. This combination of low-probability, high-consequence risk is fairly common in high-technology issues.

Consequently, several new disciplines are evolving in the study of risk: risk perception, communication, and management. The study of risk perception is increasingly recognized to be important, because how people perceive a risk affects not only how they feel or what they do, but how they spend their money.[6] The study of risk communication examines the "bridge" between risk assessment and risk perception--how can information on risk be meaningfully conveyed? The study of risk management includes ways to prevent, reduce, or manage risks and perceived risks. For example, since people generally believe that events they control are less risky than those they do not, one technique for managing perceived risk is to give people greater control. Allowing local citizens to participate in the process and in the decisions made will increase their sense of control over the industry, thus decreasing their fear or perceived risk of development.

This report addresses risk assessment separately from risk perception, communication, and management.

Washington state probably is reasonably well prepared to manage safety and risks for most of the disasters or emergencies it currently faces. Since the state has never dealt with offshore oil and gas development, the state does not have systems that specifically attend to that issue. The state does have four oil refineries, each with a marine terminal, so oil transportation and processing risks are not new (Figure 5.3). Washington can also use other technological issues it has faced (for example, fixed nuclear facilities) as models of how (or how not) to deal with safety and risk.

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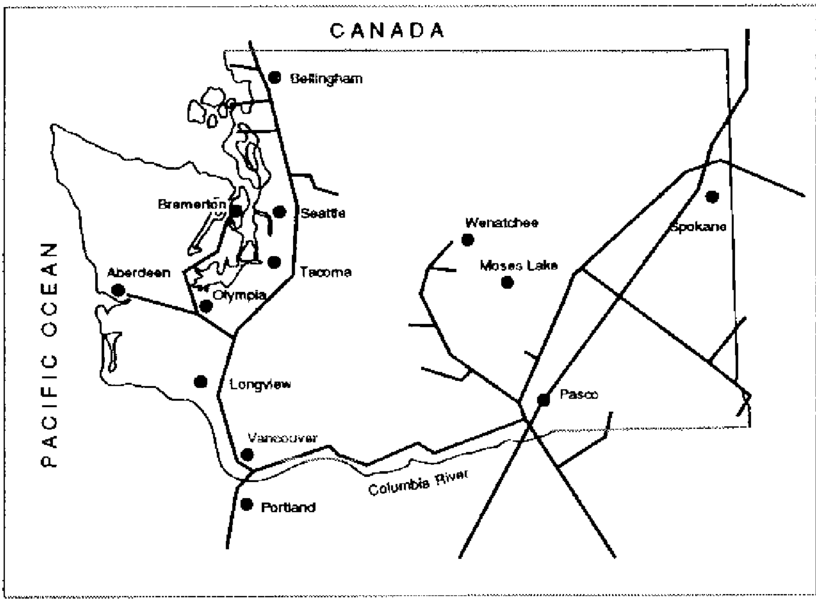
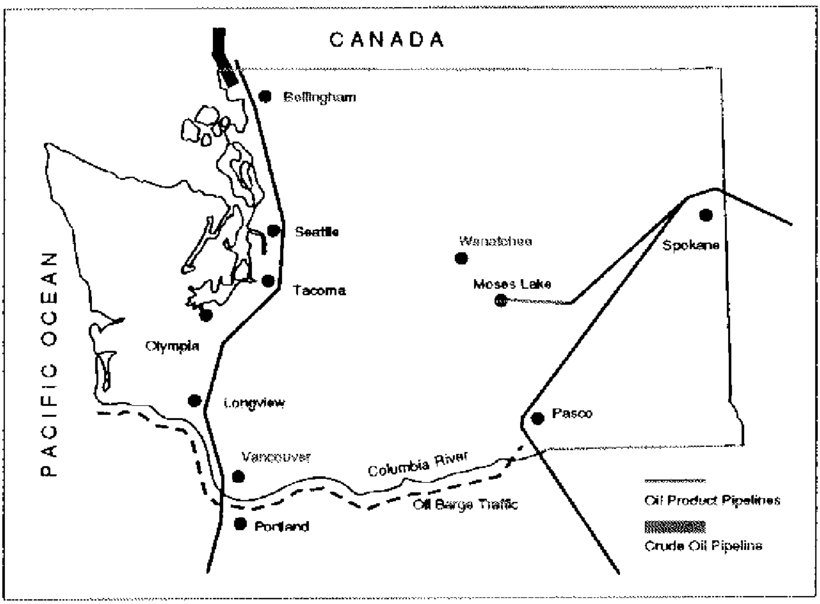
[6] As an example, in the cranberry crisis of 1959, the *threat* of contamination caused Thanksgiving sales of cranberries to crash, nearly crippling the cranberry industry.



Natural Gas Pipelines in Washington State



Oil Pipelines in Washington State

Figure 5.3 Natural Gas and Oil Pipelines in Washington. The state is a non-producer of petroleum.

Management of risk and technology is in every case a challenge. Managing risks of offshore oil and gas presents particular challenges because of the unequal distribution of risks and benefits. The risks of offshore development fall primarily on the people in nearby communities, while the benefits accrue to the nation as a whole and to the investors. In risk analysis and impact assessment, these equity issues are proving to be a crucial feature of socio-economic analysis and mitigation.

Cleanup technology is effective only in comparatively calm seas. Thus, the rough seas off Washington's coast are a cause for concern. The use of dispersants also needs further study to determine their safety and effectiveness. (The National Academy of Sciences has nearly completed a review of dispersant usage on the sea.)

The developer is as interested as the state and federal governments in developing sound information on geological stability and potential environmental risk. Topics of interest include faults, seismic activities, and other geohazards and water current and weather extremes that may affect exploration and safety.

Risk Assessment. What are the factors that either increase or decrease the risk of accidents and the severity of effects? There is some risk of a disaster during the drilling of an exploratory well, although the number of wells drilled during exploration is much less than during development, so the risk is somewhat lower. During exploratory drilling, however, less has been identified about the geology of an area and possible geohazards, so that there are many unknowns. In spite of the unknowns, ". . .industry's safety record is best for frontier area drilling," perhaps because "more precautions are apparently taken in exploratory wells and deep-water wells."[7] At this time there have been no spills from exploratory operations in the United States.

Potential emergencies include natural disasters, fires, industrial accidents, blowouts and explosions, with consequent fires and oil spills, if oil were present.

Risk Perception/Communication/Management. It is important to learn more about risk perception, communication, and management, because risk assessment has been totally inadequate in helping the public deal with the kind of low-probability, high-consequence risks that offshore oil and gas development presents.

During the exploration phase, Washington needs to gather specific information so that it can reduce, manage, and mitigate the risks that exist with the offshore industry. It is important to look beyond the risks of exploration, to try to make the right safety choices in the beginning.

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[7] Kennedy, John L., *Fundamentals of Drilling—Technology and Economics*, Tulsa, Oklahoma: PennWell Publishing Co., 1983, p.155.

Other states advised that the decision processes surrounding risk management are difficult, yet a clear response process must be determined before, rather than during, an emergency.

DEVELOPMENT PHASE INFORMATION DEMANDS AND GAPS

Several new information concerns appear during development, a busy drilling and construction period.

Environment

Fish and Wildlife. Many of the fish and wildlife resources of the Washington coast are potentially vulnerable to changes in the natural system. Even though the industry will attempt to cause minimum environmental interference, particularly vulnerable animals could be affected by the effluents of drilling (disposal of drilling muds and cuttings and produced water), by oil spills, and by the decisions made in selecting locations for onshore and transshipment facilities. Adequate information is essential for the state to mitigate and monitor impacts effectively (Figure 5.4).

As explained under the Exploration section, little is known about the offshore fish and wildlife resources of Washington beyond the commercially harvested species. The overall lack of critical information is even more significant for offshore birds. Year-round, seasonal observations of offshore birds have not been made and life history information is minimal at best, often based only on casual observations. A wide variety of birds feed in or migrate through the Washington offshore area and more are

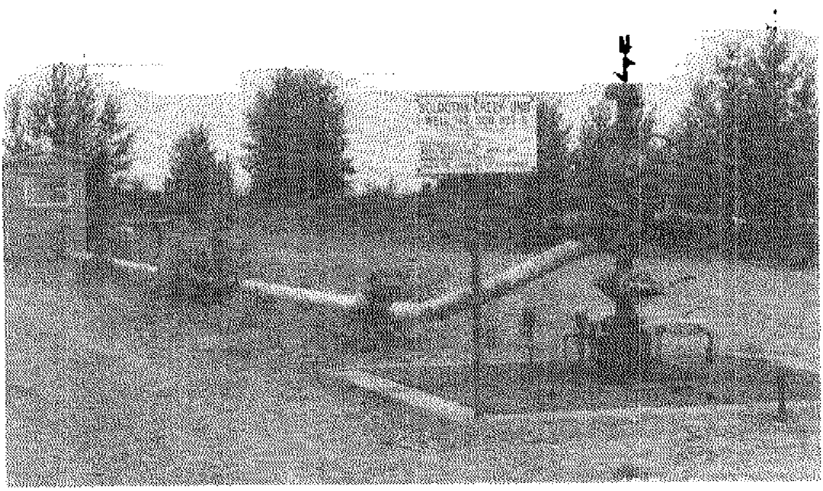

Figure 5.4 Oil production at the Swanson River Field in the Kenai National Wildlife Refuge. (Photo: Kenai National Wildlife Refuge)

dependent on the coastal estuaries. Some offshore species are known to concentrate in large numbers at specific locations such as submarine canyons, oceanic fronts, and convergence zones. The potential for impact in these areas of high concentrations is obviously increased.

Sea otters are one of the few marine mammals currently subject to research. The information being collected on sea otter food habits is supplying some of the only intertidal and shallow subtidal invertebrate data on the north Washington coast.

Because fish, marine mammals, and birds do not live in isolation, much of the information needed is about their environment—information about marine systems. Topics of interest include offshore marine habitats and seasons for feeding, breeding, and migrating for particular fish, mammals, and birds. The locations (critical habitats) and times that are sensitive for marine animals and plants need to be identified. For example, are there seasons when the estuaries are particularly vulnerable?

Since some oil spills, whether small or large, are a certainty, there is a need to understand environmental pathways of spills and the nature of effects on critical habitat and recreational areas that oil spills might reach. In addition, spilled oil that gets on sea otter fur or seabird feathers affects the animals' insulation and buoyancy, causing almost certain death. Thus, means are needed to reduce exposure of these species to oil spills.

Marine Systems. There are a variety of potential effects on marine systems from the offshore oil and gas development and production. The state of knowledge about the lower marine plants and animals is generally much less than about the commercially and recreationally important fish and wildlife. However, these resources—plankton, benthic communities, and sub- and inter-tidal communities—support the species commonly harvested.

Water Quality. There is a great deal of information available concerning the effects of oil and gas development on water quality. This issue has been the subject of a multitude of studies at existing oil and gas facilities in a variety of settings. Within Washington, the need is for information which will provide linkages between the large body of existing knowledge and Washington state resources and offshore conditions. During well drilling, the needs include concerns about drilling muds and production water discharges. During development and later production, needs include information on oil and diesel spills, blowouts, seepage and leakage, cleanup and dispersants, and the impacts of support activities.

Other needs have to do with the ecology of the surface layer of marine waters, also called the microlayer.

Air Quality. There is a general fund of knowledge about air quality changes caused by various aspects of oil and gas development and production. The primary need is for development of Washington coastal data to relate to the existing information. For example, there may be sites where local air basins make potential air quality impacts a more serious problem than at other sites.

The presence of the Olympic National Park along much of the Washington coast presents unique considerations in assessing impacts, planning for development, siting facilities, and determining appropriate mitigative measures. The national park is designated a Class I area for air quality, requiring stringent controls to ensure that the area's air quality is not degraded. Issues such as potential acidification of coastal lakes may become important and require site specific information. While impacts of shipping and burning gas discharges will be important offshore air quality issues, many of the critical air quality issues will center around onshore processing facilities.

Oceanography. Oceanographic information is of great value in relationship to the environment and safety. Sea conditions will affect the stability of offshore oil rigs and production platforms; knowledge is critical to prevent disasters.

Wind, wave, tide, and current patterns largely determine the spread of spilled oil, though properties of the oil also are relevant. The knowledge of anticipated routes and destinations of oil spills from transshipment accidents could contribute to routing decisions as well as to prevention or mitigation of problems.

Offshore oceanographic features are of biological importance as well. Frontal and convergence zones (where two dissimilar oceanographic currents are brought together) produce localized heavy concentrations of plankton, fishes, and birds, important ecologically as well as to individual species.

The amount and quality of information available within the Washington/Oregon offshore lease area is variable. However, in general, there is a lack of information on the nearshore area, on cross-shelf transport mechanisms, on the near-surface layer, and about oceanographic frontal/convergence zones. Studies of value might relate to winds, waves, currents, upwelling, and frontal/convergence zones.

Geohazards. There are federal regulations relating to geological stability and potential environmental risk. Both states and developers want a projects safe from geological hazards. Information needed includes geohazard surveys for seismic activity and faults.

Use Conflicts

Fisheries. Fisheries support a major portion of the coastal economy. The potential impacts of oil and gas development and production vary with the fishery and the industry facilities and activities. Construction of drilling and production facilities or support vessels on the fishing grounds can impede fishing activities. In addition, oil, toxic materials, and drilling discharges can affect the fish. Because of the number of wells involved, drilling impacts are potentially greater during development than during exploration.

Studies currently underway include work funded by the MMS to summarize and, to the extent possible, standardize fisheries catch information. The intention is to computerize the information for use in environmental planning and assessment.

The opening weeks of Dungeness crab season provide an example of potential physical interference. Crab fishermen deploy approximately 45,000 crab pots off the coast. If the buoy lines on the crab pots become entangled in passing vessels, the buoys may be severed or the pots moved. The result will be loss of gear and resources. The lost gear will continue to "fish," entrapping crab which die, unharvested, in the lost pots. Currently, crab fishermen have negotiated seasonal areas and lanes with towboat operators (Figure 5.5).

Potential topics for study include assessing the current fisheries' situation and analyzing probable impacts as well as developing protective measures. Studies should encompass commercial and recreational fishing,

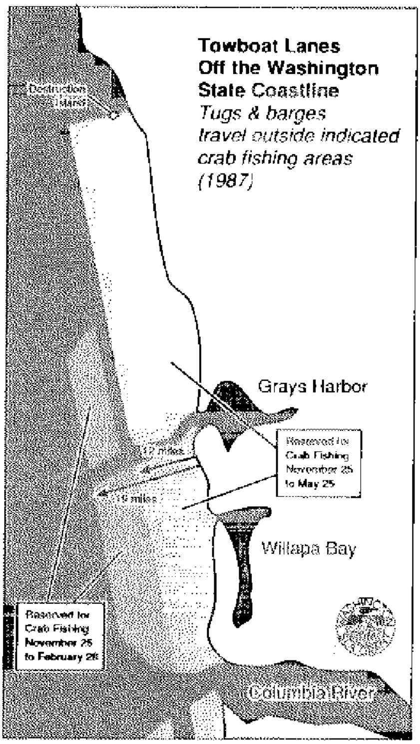

Figure 5.5 Conflict Avoidance: Tugs, Tows and Fishing Boats. To avoid conflicts with commercial crabbing operations, tugs and barges travel outside the indicated areas during the crab fishing season. The areas are negotiated annually and participation in the system is voluntary.

fisheries conflict resolution and compensation, socio-economics of fishing conflicts, and the effects of oil industry development on eggs and larvae.

Navigation. There are a variety of navigation-related issues in the offshore area. Navigation issues can be a source of use conflicts in that the well-drilling equipment and construction of production equipment, together with the service vessel traffic they generate, will interfere with other vessel traffic. There will be a considerable amount of support vessel traffic to and from existing ports during the development and production phases. There may also be a shortage of space in ports. Oil and gas development may conflict with some military uses of the coast as well.

It is difficult to predict the specific impacts of platforms, support vessels, and oil tankers on vessel traffic until the locations of development are known. Ultimately, information on navigation issues should funnel into siting decisions for onshore facilities.

Navigation topics for consideration include channel mapping, possible designation of traffic lanes, tanker routes and waiting areas, safety considerations such as radar reflectors and automatic alarms, vessel traffic control, and use-conflict mitigation.

Tourism and Recreation. There are recreational values that may conflict with oil and gas uses of the same area, while at the same time there may be benefits arising from the physical/biological effects of the production platforms.

Figure 5.6 Birds Along the Coast. Shorebirds, waterfowl and seabirds are important users of the Washington coast and offshore waters. More than two million shorebirds feed in the estuaries during their spring northward migration along the Pacific Flyway. Estuaries also are wintering areas for more than 100,000 waterfowl. Summer breeding along the northern coast occupies almost 250,000 seabirds of 16 species. During fall, seabirds feeding along the coast and shelf probably number more than one million. (Photo: Carolyn Pendle, ORAP)

It would be worthwhile to identify the non-consumptive recreational uses of the offshore area, such as photography, whale watching, bird watching, and small boat uses, as well as the consumptive recreational uses, such as fishing and digging clams (Figure 5.6). All such activities draw people to the Washington coast. What is the economic value of tourism and recreation compared with competing uses? (MMS is funding the National Park Service to do a study of potential impacts to tourism and recreation.)

In addition, the potential for beneficial effects, such as platforms becoming artificial reefs, should be examined.

Science/Research. Although scientific research is usually associated with some other activity (fisheries, defense, oil development, etc.), so much research is in progress along the coast that scientific research itself counts as a conflicting use. Whether by space conflicts with platforms or by particulate discharges into the sea, oil and gas development can interfere with research. At the same time, however, a new petroleum industry could generate a multitude of new research opportunities.

Other prospective uses of the ocean resources (perhaps a different fishery, military, recreational, or research use) should be considered and protected by safeguarding the resources that sustain those activities.

Community Decision-Making

Siting/Permitting. During the development phase, there are a great number of potential issues relating to siting facilities for treating and processing oil and gas. Depending on jurisdiction at the specific site, these decisions are made by various relevant levels of government: cities, counties, state, Indian tribes, air pollution control districts, citizens, and others. The most durable decisions will be developed by joint efforts, so that all affected parties contribute to and accept the decisions (Figure 5.7). The facilities involved may include separation and treatment plants, marine terminals, pipelines, petroleum processing plants, and support services.

The locations of facilities require major decisions and many compromises. Who or what decides among competing uses of potential facility locations?

Planning for industry facilities should allow for industry growth in terms of future facility requirements and must take into account the power or energy requirements of the operating facility. It may be possible to coordinate deliberations on siting requests, including considering generic studies for similar facilities.

One major concern in determining sites is the environmental consequence. What wastes (air, liquid, solid) will the facility produce? Will the facility meet all regulations, without exception? Is the facility near environmentally sensitive areas, like estuaries, which are vulnerable to major impacts? What measures are available to assign liability for accidents? Should

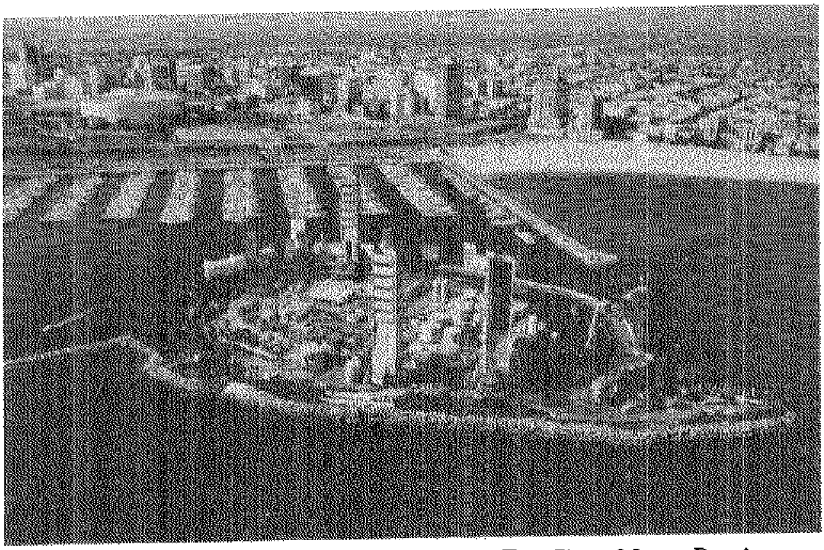

Figure 5.7 Artificial Islands off Urban Shore. The City of Long Beach, California owns four artificial islands inside Long Beach Harbor and the oil fields beneath them. They are leased to THUMS [Texaco, Humble (now Exxon), Union, Mobil, and Shell] which had produced 613 million barrels through July 1985. Ultimate production is projected at about one billion barrels. The 178-foot derricks are mounted on rail tracks, and about 1,140 wells (some six feet apart at the surface) have been directionally drilled beneath the four islands. Constructed in 1965-66 of rocks and sandfill, the islands are in water depths of 25 to 40 feet and rise to elevations of about 15 feet above mean low water within about 1,500 feet of the shore. The derricks have been sound-proofed and are sometimes mistaken for apartment towers. (Photo: Shell Western E&P)

the state have a standard cleanup policy that specifies under what conditions spills should be treated with dispersants, or contained, or left to nature? Would such a policy affect the state's liability?

Some, if not all, processing could be handled through offshore shipboard facilities. If offshore facilities are used, the petroleum must be "lightered" or transferred from one vessel to another for transportation away from the well site. If the offshore facilities are located beyond the three-mile limit of state waters, Washington state limits and controls on air and water quality will not apply, nor will state tax regulations.

The location of various types of support and processing facilities in the offshore/onshore area could be examined at the conceptual and policy level as well as at the site-specific level. As an example of the many questions that must be considered, does Washington generally prefer to transship oil by pipeline, tanker, or barge? Then, for a specific platform, what alternative methods of transportation are the safest? cause the least environmental disruption? cause the least aesthetic disruption? For a pipeline, what route is safest? causes the least political dissention? What information is most important for making siting decisions? Which technique of laying pipelines is most acceptable? Where should the pipelines come ashore? What dimensions of pipeline should the state regulate? How will the state process permits? How will the tribes, counties, etc., participate?

The development phase, a period of heavy construction and activity, has the greatest impact on local communities. Typically, that is the only time when there may be significant local hiring. Communities must also build their infrastructure and meet the needs of the workers. Housing, schools, and services such as medical facilities must be available. Meeting these needs without over-building or over-developing is a challenge for local communities, because the number of local people employed will decrease substantially when the production phase begins.

Jurisdiction. Jurisdictional issues could complicate many decisions regarding offshore oil and gas—questions about federal versus state roles, or state versus county roles, or county versus city roles are possible. Some jurisdictional questions arise when appropriate authority has not been determined; other issues evolve when authority is not exercised.

One of the most complex jurisdictional issues will be the roles of the Indian tribes. The tribal fishing rights in Washington state differ from conditions in most, if not all, of the other outer continental shelf (OCS) oil and gas leasing areas. Northwest tribes have treaty rights to half the harvestable salmon and steelhead. In addition, the tribes have the right to other species historically harvested, even though such harvesting may be limited today. The tribes take their catch in "usual and accustomed places," which makes the tribal harvest less flexible and mobile than some non-tribal fisheries. Legal interpretations of the treaties give the tribes influence over environmental matters which affect treaty resources. Tribal rights have a potential effect on more than just the development and production phase of the offshore oil and gas industry. These issues pervade all aspects of oil and gas development. The unique status of Washington tribes has led MMS to fund a study examining this issue.

In addition, there are jurisdictional issues involving states' rights during OCS oil and gas development. Disagreements over state versus federal authority could emerge over "consistency determination" for OCS activities under the Coastal Zone Management Act (see Chapter 2). Other state/federal jurisdiction questions might appear about tanker routing or vessel traffic control. In fact, the question of appropriate balance between state and national interest deserves thorough examination.

Jurisdictional questions arise at all levels of government. Which state agency should regulate oil spill clean up? regulate emergency response in state waters? issue permits? One key to the state's successfully managing a new offshore oil and gas industry will be the degree to which it can organize itself and balance competing interests. Government must resolve its own conflicts between levels of government and/or industry, and ensure equity between various levels of government.

These are the types of decisions made each day by the legislative, executive, and judicial branches of government: Who is responsible to do what? Yet to work out new systems for an activity new to the state, involving a unique set of public and private entities, will require information for the decision makers. What are the activities involved, the impacts, the precedents, and the possible processes?

The advice from Alaska and California is to begin discussions with all involved parties from the very beginning, working together, creating a joint effort to reach decisions.

Operating/Monitoring/Enforcement. The ability of any regulatory agency to achieve environmental or public benefit is dependent on the adequacy of the restrictions applied to an operating project and on the agency's ability to enforce the permit conditions and stipulations applied. Monitoring and enforcement are critical activities. Determining the appropriate regulations, permit conditions and stipulations for an industry in a new area requires preplanning. Once these conditions are developed, the enforcement depends on adequate staffing within the agency (numbers of personnel, training, and budget constraints), as well as on self-regulation, compliance, and policing.

In non-frontier areas (places with oil and gas production), the revenues which accrue to the state from oil and gas lease sales and production are used to fund planning activities as well as monitoring and enforcement efforts. In frontier areas, funding for planning and permit enforcement, necessary at both the state and local levels, is more problematic.

Potential areas to consider include bonding requirements, the monitoring capabilities of companies, and the capabilities of state and local governments to monitor stipulations. For example, should the oil and gas industry, the new component in the system, provide adequate funds to support environmental and socio-economic monitoring, so that extra burdens do not fall on the local areas at risk? What emergency response measures are necessary? Should there be a coordinated emergency response approach among private and public groups? What is the government responsibility for emergency response? What is the government liability?

Socio-economics. Socio-economic monitoring must continue throughout development and production in order to identify and attribute impacts. (The profile socio-economic study of the coastal counties that MMS is currently funding is a preliminary step and does not meet this need.) The results of monitoring drives the allocation of impact funds and helps in the disbursement of federal-state revenue sharing. As development activity increases, impacts will also increase, and conflicts are likely to increase. Thus, an effective process of conflict resolution becomes more and more important.

There may be several economic benefits to a community from oil and gas development. Transshipment is one area where benefits may be identified. During development, there will be noticeable local service and employment needs as the transshipment facility is installed. When operations begin, some local service needs will continue.

Personal and Interpersonal

There are aesthetic values to the Washington coast as well as resources there. The pristine wilderness of the Washington coast is highly valued by the people of the state. Transformation of the coast to an industrial zone supporting oil and gas development would raise serious concerns.

The evaluation and management of aesthetic issues is largely ignored in present environmental processes. To fully account for these impacts and develop appropriate mitigation strategies will require new social research methodologies.

Safety and Risk

Safety. Safety issues grow even more important during development because the amount of offshore activity is greater. Consequently, the risk is greater. Transshipment safety, public health, and environmental safety will all require attention.

Risk Assessment. Risk assessment can apply to a host of topics during the development phase. Oil spill risk and matters involving human safety are two. Issues relating to health and human safety may be of special concern to local residents during the planning for development and production.

Potential risk assessment topics include oil spills (including Washington and Oregon sea conditions and geohazards in the analysis), spill sizes less than 1,000 barrels (the minimum considered in an EIS), or calculations for oil development greater than federal EIS projections. Risk analysis is also needed for other types of risk, such as blowouts, fire, explosion, toxic fumes, and rammings and collisions at sea, or for operational risks of transshipment activities. In addition to examining risk of acute, accidental impacts, analysis of risks from chronic, low-level exposures or changes is important.

Risk Perception/Management/Communication. At this stage, Washington needs to continue to work to prevent, reduce, manage, and mitigate the risks that exist from the offshore industry.

PRODUCTION PHASE INFORMATION DEMANDS AND GAPS

A few additional information concerns emerge during production, as all the facilities begin operations.

Environment

Fish and Wildlife. During the production phase, in addition to being vulnerable to impacts from oil spills and drilling discharges, the fish and wildlife resources of the Washington coast could be affected by releases from various types of processing facilities. This, again, reinforces the need for information on marine systems, offshore and nearshore marine habitats, and seasons for feeding, breeding, and migration for fish, marine mammals, and birds (Figure 5.8).

Water quality. Throughout the production phase, issues such as potential acidification of coastal lakes may become important and require site specific information. Many of the air quality issues will center around onshore processing facilities. During both development and production, needs include information on oil and diesel spills, blowouts, seepage and leakage, and state and federal laws affecting water quality and discharges. Other information needs have to do with the microlayer ecology, oil cleanup response capabilities, dispersants, and impacts of support activities.

Air quality. Air quality issues will continue to require monitoring of offshore production platforms, onshore facilities, shipping impacts on air quality, potential acidification of coastal lakes, mitigation banking, as well as state and federal air quality laws.

Use Conflicts

Fishing. During production, throughout the life of the field, use conflict with various fisheries will continue. The presence of production facilities or support vessels on the fishing grounds may directly interfere

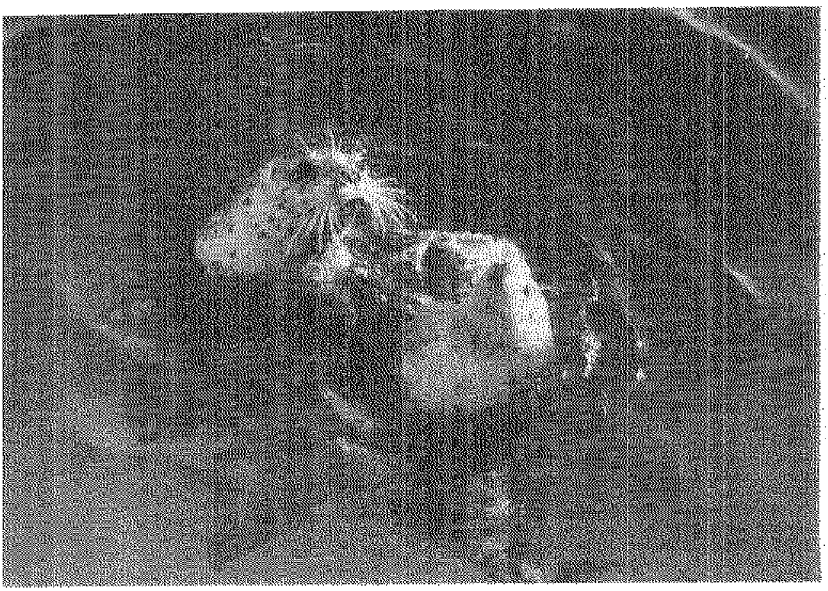

Figure 5.8 Harbor Seals. Harbor seals are among about 30 marine mammals that inhabit or visit Washington coastal waters. For the state as a whole, the total population of harbor seals probably exceeds 18,000. (Photo: Carolyn Pendle, ORAP)

with fishing activities. In addition, impact on target species due to oil, toxic materials, and discharges can affect the fishery. Aquaculture may be particularly vulnerable if there are discharges near Willapa Bay or Grays Harbor.

What is the long-term picture? What will be the long range impact on any species after perhaps 30 years of petroleum production?

While platforms may conflict with fishing and other uses, they may also provide certain benefits. It is possible that platforms could help the state develop other recreational and commercial fishing activities, such as harvesting shellfish from the jacket or taking advantage of the artificial reef, which may attract certain species of fish, for sportsfishing.

Topics to investigate would include the extent to which platforms could be useful for shellfish harvesting or for sportsfishing in the Northwest.

Community Decision-Making

Operating/Monitoring/Enforcement. Monitoring and enforcement of discharges and releases from separation and treatment facilities and of processing facilities will continue to be a responsibility for governments throughout the production phase. Is there adequate funding and staffing to monitor facilities and transshipment operations? Are the initial standards that were agreed to still adequate? inadequate? too restrictive? Is there a method—or should there be a method—for reopening agreements?

In addition to dealing with the traffic demands of the supply boats, during the production phase there may be increased vessel traffic due to transshipment of the oil or gas (unless everything is piped).

Water quality and air quality will require continual monitoring and assessment. Are federal, state, and local water and air quality laws adequate? Water quality concerns will include short- and long-term monitoring as well as applicant and subcontractor liability. Decisions must be made on oil spills, capabilities and procedures for cleanup response, and use of dispersants.

Important air quality issues are impacts of shipping and burning gas discharges. Because the entire Washington coast is an attainment area (unlike Santa Barbara, which is a non-attainment area), mitigation banking is not a factor in Washington. In California, mitigation banking, by federal law, allows a company to negotiate and make net improvements to air quality to offset its negative impacts to air quality.

Socio-economics. What kind of economic benefits can be realized from a healthy transshipment industry during production? from other production activities? What will the costs be? How can the state and local areas be prepared to handle the change in pace between development and production activities?

Personal and Interpersonal

What would be the long-range impacts on people's feelings and beliefs after thirty years of offshore oil and gas industry operations? Would the effects be different for coastal residents and inland residents? How would the state change?

Safety and Risk

Throughout the 30 or more years of production, the state must continue monitoring safety and risk, to be sure it is able to prevent, reduce, manage, and mitigate the risks that exist from the offshore industry. Furthermore, as technological advancements improve safety and reduce risk, mechanisms must exist to implement those new technologies.

During production, transshipment becomes a bigger issue. What are the concerns about increased tanker and barge traffic?

Pre-Lease Stage Implications

In developing a sense of what information would be needed during different post-lease stages of offshore oil and gas industry operations, Committee members also developed ideas of what Washington needs to know as early as possible, during the pre-lease stage.

Environment

During the pre-lease phase, the Committee recommends that broad-based, reconnaissance and survey studies be conducted to identify areas that need more intensive study. As a first step, and with the first commitment of dollars, the Committee is not recommending in-depth research on one particular issue. By way of example, the type of information which should be collected at the first stage is distribution and abundance data rather than ecosystem studies. Although the ecological information would be very valuable at the pre-lease stage, the area involved in the potential lease sale is too large to allow for an in-depth study throughout the entire area. Instead, studies should be designed to determine locations of resources (fish, wildlife, etc.) over an extended area, identifying their temporal variations.

Within the state of Washington, these studies are often called "baseline" studies. However, it is not enough to just go out and measure. The needed studies, in addition to assessing current levels, must identify the critical environmental and ecological parameters in areas of possible hydrocarbon development. Furthermore, the data from these reconnaissance studies must be made available to decision makers in a form useful to them.

Follow-up studies should emphasize areas that are known or suspected to have heavy concentrations of species that could be impacted by offshore oil and gas development. More detailed studies will be needed when exploration and development is scheduled or projected in specific locations.

Ideally, basic studies should be completed for not only animals, but also plants, habitat, air quality, water quality, geology, and land values. It would be particularly useful if a low-cost, accessible, geographic information management system were developed before the lease sale.

Use Conflicts

The state needs to study use conflicts and understand the industries that may be affected so that potential conflicts may be avoided or else mitigated after the lease sale. Preventing or compensating for damage to resource users will require that good lease stipulations be developed.

Community Decision-Making

Operating/Monitoring/Enforcement. In order for a regulatory agency to effectively benefit the public, it must develop adequate restrictions for any project and must enforce the lease stipulations and permit conditions. Determining the appropriate regulations, lease stipulations, and permit conditions for an industry new to an area requires preplanning. Once these conditions are developed, the enforcement depends on adequate staffing and attention within both the enforcing agency and industry.

During the pre-lease stage, planning is critical and must provide for:

- Adequate revenues to manage early impacts and activities
- Public education about offshore oil and gas
- Stronger state capability (expertise and organization)
- Design of a balanced, fair process

In order to begin successfully a planning program, state government must organize effectively and early to devise a planning process that balances competing interests and ensures equity. A joint effort that allows all affected groups to participate in the decision-making process may be a solution. There is a need for prudent intergovernmental collaboration to ensure that divide-and-conquer strategies cannot be effective.

Jurisdiction. State and federal jurisdictional issues are a problem even at the lease sale stage, and are not unique to this OCS leasing area. In a recent court decision, states were told that during the lease stage they cannot make a "consistency determination" for OCS lease sale activities under the Coastal Zone Management Act, since the sale itself does not physically impact the coastal zone. Pending federal legislation (Senate Bill 1412, HR 3202) would institute the consistency requirement for oil and gas lease sales. In addition, this legislation attempts to clarify the applicability of consistency requirements to federal activities seaward and landward of the coastal zone if the activities affect the coastal area.

Socio-economics. Because the system for monitoring socio-economic impacts must be operational at the time of the lease sale, baseline studies should commence well before the sale. These studies should allow perhaps two years of data to illuminate annual variations in the context of 5 years of historical data analysis. The state needs to identify potential impacts of the oil and gas industry and to consider both monitoring and mitigation techniques. Two particular areas that require more investigation are profiling coastal-dependent industries and studying use conflicts between the new oil industry and the existing fishing or tourism industries.

Personal and Interpersonal

Social impact analysis is beginning to address such issues as equity issues, inter-generational effects, as well as risk perception (discussed earlier). These topics deserve attention. Early work to document the personal value and meaning of the coast and ocean to Washington residents would also provide important socio-economic data for future studies.

Safety and Risk

Risk identification should be studied in the pre-lease phase to prepare for the EIS. Identification of major risks is probably not difficult, and certain questions already have been raised.

After risks are identified, the more complex issues remain: risk reduction, risk management and mitigation. A major issue needing resolution is the equity dilemma, i.e., most risks fall on local communities but most benefits accrue to the nation and investors. Such concerns will extend into the post-lease process.

6

Information Priorities

The ORAP Advisory Committee has identified information priorities for Washington to make effective decisions during the offshore oil and gas leasing, exploration, and development process. This chapter lists the Committee's recommendations for study and attention. Because the information needs for the pre-lease phase require the most immediate attention, they are presented first, before the information priorities for the post-lease phase.

Chapter 5 of this report discusses the complexity of concerns and questions identified by the Committee. Each issue or topic addressed in Chapter 5 generates the need for certain information or research. Chapter 6 identifies which of these information needs should be fulfilled first, based on (1) the importance of that subject to Washington state and (2) when in the leasing process that information is needed. The Committee also considered topics in terms of the likelihood of impact from oil and gas development and the perceived level of knowledge about the subject. All the information priorities that follow are topics that are of high importance to Washington.

Not all these information priorities require formal, scientific research. In some cases, the information needed requires new research, involving the scientific collection of data, with analysis and interpretation of information. In other cases, synthesis, analysis, and communication of existing information is all that is needed by the decision makers. Finally, in some cases, the priorities noted by the Committee may essentially require only decision-making, but they are agreed-upon priorities for action, which require information to be available. (Refer to Appendix E for a list of research projects that provide some relevant information.)

In all cases, this statement of informational needs attempts to avoid policy recommendations. Politically representative institutions, together with those agencies responsible to them, should devise the policies as well as the processes to implement policy.

Although each individual Committee member may have a somewhat different list of priorities, the Committee agreed that these information priorities are general topics that need immediate attention. It is anticipated that Washington Sea Grant will develop these recommendations further in the course of creating a studies plan that is much more specific than could be developed by the Advisory Committee in five months.

Pre-Lease Priorities

At the early, pre-lease stage, the level of detail for proposed studies must be limited because of the large size of the study area. The information should also be relevant and important to the state regardless of whether the offshore oil and gas development process continues. Currently, very little is known about where or if offshore oil and gas development may actually occur off Washington's coast. The area that Lease Sale 132 encompasses is so large that obtaining any site-specific information on impacts does not appear cost-effective until specific sites are identified. Thus, these recommendations urge that preliminary studies be broad-based surveys, accumulating information that could apply to any specific areas subsequently identified for oil and gas development. Studies should aim to achieve multiple objectives. Conversely, should offshore petroleum development not proceed, the completed studies should create a knowledge-base useful in understanding other changes or conflicts that could affect natural and socio-economic systems in the state.

The following topics are of prime importance to Washington during the pre-lease phase. The first topics require research or information-gathering; the items at the end of the list are primarily action items or institutional questions, as indicated.

- *Understanding the Existing Natural Environment*
  Surveys of distribution and abundance of marine and coastal animals, plants, habitats, and land uses and values are needed to identify sensitive environmental areas, species, life stages, and seasons. This information is required so that the state can identify those areas or species that it must protect. Protection may include either devising methods of mitigating impacts or setting aside critical areas where development is excluded. If reconnaissance and survey studies are designed appropriately, the data can also provide the background information that is needed for monitoring purposes, should offshore oil and gas leasing continue into exploration and development phases.

- *Understanding Washington Fisheries*
  Compilation of fisheries catch data, including fish landings and locations of the catch, is necessary to describe and understand the fisheries adequately. Analysis of fisheries should not be just a "snapshot" of current fisheries but should consider that some stocks are currently depressed and should examine under-utilized species that constitute potential fisheries.

- *Jurisdictional Issues*
  Information on jurisdictional issues is essential. There are questions about federal versus state rights and additional information

is needed to assess responsibility for siting, permitting, and mitigating among state, tribal, and local governments. Some of the jurisdictional issues stem from a void of information; others represent authority that is not exercised. (The Committee is aware of an MMS study of Indian tribal rights and the Joint Select Committee's examination of state's rights and other jurisdictional issues.)

- *Identifying Locations of Potential Development*
  Information is required to define better the locations of economically important geological resources—where might petroleum resources actually be found? Information on likely locations of petroleum occurrence must become known before the state can reasonably begin site-specific studies of environmental impacts or of specific transshipment and siting options.

- *Understanding the Existing Socio-Economic Systems*
  Socio-economic baseline studies should commence two years before the lease sale in order to adequately define seasonal and inter-annual variations. These studies will be necessary for attributing economic impacts and benefits to local coastal communities and to existing users of the offshore and coastal areas. Also needed are (1) the ability to model (assess and project) the potential social, demographic, fiscal, public service, and economic impacts, and (2) procedures and strategies for mitigating impacts.

- *Understanding Use Conflicts*
  Studies of space/use conflicts, especially between offshore petroleum industries (exploration, development, and production activities) and existing state fishing and tourism industries, will require understanding the various users, the sources of conflict, and the techniques to prevent, reconcile, compensate, and mitigate the problems. Use conflicts require early attention because the issues are apt to be contentious and difficult.

- *Navigation and Shipping*
  Information on navigation and shipping—including topics such as channel designation, traffic control, communication systems, ship safety requirements, crab fishing areas, berthing space, etc—is needed to prevent or minimize space-use conflicts and safety concerns.

- *Understanding Ocean Dynamics*
  Oceanographic surveys (wind, wave, current, and convergence zones) that can help determine possible trajectories and

destinations of potential oil spills are needed. Such information is necessary in risk analysis, in decision-making about transshipment and facility-siting, and also in understanding and correlating variations in biological resource concentrations.

- *Ensuring Documentation of Existing Air and Water Quality*
  Assessments of the currently available baseline data on air and water quality can determine whether additional information is necessary. If currently recorded data are not sufficient, the collection of baseline data should be expanded.

- *Identifying Risks*
  Risk identification studies are needed since they could affect what subsequent studies are deemed most important. Additional information is needed on risk perception, communication, and management.

- *Information Management*
  A low-cost, accessible geographic information system would make environmental and socio-economic information easier to understand, correlate, and retrieve, improving planning, research, and decision making.

The following pre-lease topics, of equal importance with the preceding informational needs, are primarily action items and institutional questions.

- *Lease Stipulations*
  The state needs to compile information about Washington resources, impacts of petroleum development, and experience in other states to develop a stipulation package for a variety of issues to ensure that the state can protect and/or develop resources and respond to events effectively.

- *Assisting Local Governments*
  Local governments, in cooperation with state and federal agencies, should consider pre-lease planning, public education programs, and programs to manage potential development and speculation. Accurate information on existing land and shorelines uses is not easily available for coastal Washington. The possibility of OCS oil and gas exploration, development, and production requires an effort to expand the information readily available to coastal counties.

- *Organizing and Coordinating Decision-Making*
  The state needs information to assess the organization and coordination of state government for handling offshore oil and gas development; to ensure effective and adequate participation at all levels (each will have primacy at some point); and to establish procedures for resolving conflicts and balancing competing interests among governmental bodies and between government and industry. Washington must develop a predictable process for managing the issues in order to keep pace with the knowledge, mission, and procedures of the federal process and private industry.

POST-LEASE PRIORITIES

There is a change in the type of information needed once the leasing process is assured and the number of locations of possible exploration and development has been defined by the bidding process. Currently, the actual areas of possible development are specifically identified only when industry interest is made known in the bidding process, although MMS and the Department of Interior may exclude some areas earlier by means of area deletions.

As potential locations are defined, there is a need for increasingly specific scientific information. Rather than providing background and baseline information, studies must explicitly provide guidance for choices or decisions that must be made.

The following topics are especially important to Washington during the post-lease, pre-development phase:

- *Environment*
  The distribution and abundance studies completed in the pre-lease phase, together with the known locations of possible petroleum development, point out the environmental studies that are needed next. Additional environmental research should concentrate on species and habitats most vulnerable to impacts of petroleum development. Studies should focus on understanding how particularly sensitive species and sensitive habitats would be impacted by petroleum development and on effectiveness of mitigation techniques (Figure 6.1). Ecological and biological systems information becomes important.

- *Risk/Benefit Assessment*
  As locations of development are identified, the state can begin specific risk/benefit assessments, examining risks of events such as oil spills, fire, and explosions, and their effects upon health and human safety, taking into account the specific oceanography, geography, and population of sites under consideration. This

risk information is needed for many of the decisions (siting, transshipment options, etc.) that follow.

- *Economic Assessments*
  Studies need to examine the likely economic benefits and costs of offshore oil and gas industry development at the state and local levels. Further, can net benefits be assured to state and local areas, ensuring that development pays its own way?

- *Assessments of Community Needs*
  To improve decisions on facility siting, the state and local governments need to analyze areas where onshore facilities (pipelines, marine terminals, and separation and treatment facilities; possibly some kinds of processing facilities) are compatible and incompatible with existing land uses and designations.

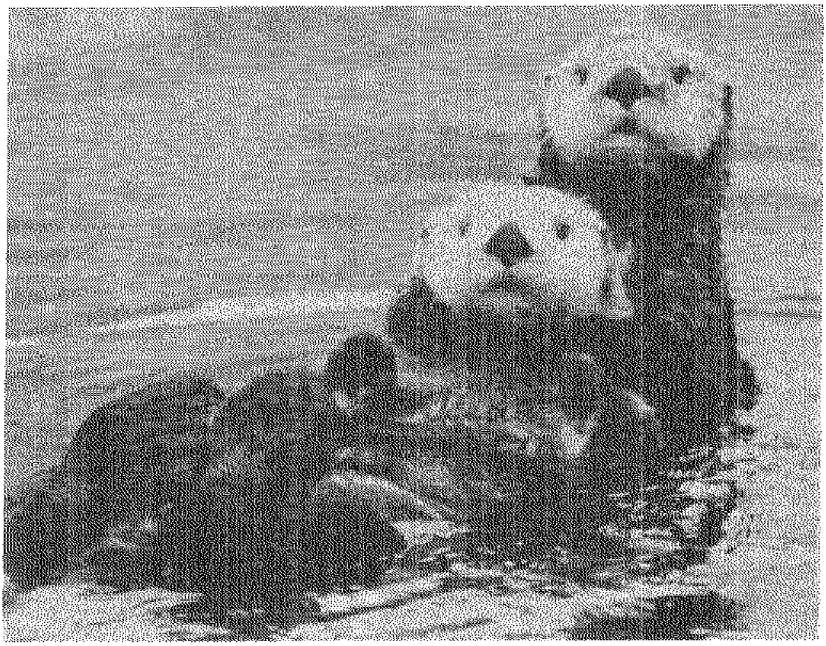

Figure 6.1 Sea Otters. Some 136 sea otters along the northern coast are vulnerable to oil spills. (Photo: Steve Jeffries, WDW)

- *Information for Siting, Permitting, and Policy Decisions*
  State, local, and tribal authorities need environmental, oceanographic, socio-economic, and risk information to make decisions and establish criteria for the use of pipelines or other transshipment options, and for onshore versus offshore processing.

- *Conflict Resolution*
  Studies of conflict resolution will be needed to resolve use-conflict issues.

- *Spill Containment*
  Additional information is needed on methods of preventing and controlling spills and on cleanup. The state needs to evaluate the alternatives, define the requirements for industry, and create a predictable cleanup process or system of response measures. In particular, the use of dispersants must be examined for impacts on unique Washington resources, such as water quality in the bays or species of juvenile salmonids (including effects of smoltification). The state must then evaluate whether to develop specific procedures or criteria for using dispersants.

While the preceding topics involve data gathering and information analysis as well as decision making (action), the following topic, of equal importance with the preceding informational needs, is primarily an action item or institutional question.

- *Monitoring, Regulating, Enforcing*
  For the state and local governments to protect the environment, health, and safety, they must decide how to monitor petroleum industry activities and how to design and enforce permit conditions and regulations. The state and local interests also need information on how best to fund monitoring and enforcement.

JUSTIFICATION FOR INFORMATION NEEDS

As it confronts the issues generated by potential offshore oil and gas development, Washington is faced with an unfamiliar industrial activity that would cause a multitude of changes to existing natural and socio-economic systems, described in Chapter 5. Making decisions under such circumstances of change requires good information. Other characteristics of offshore oil and gas place additional demands on decision makers.

LOW-PROBABILITY, HIGH CONSEQUENCE RISK

Industry and MMS point out that oil and gas technology, systems, and safety have a credible record; what is engineered and accomplished is impressive. Yet the industry operates in a world where the likelihood of risk may be low due to safety systems and controls, but the damage caused by any accident can be great and affect many people. Despite the sophistication of the technology, the risk can never be totally eliminated, particularly due to human factors. Such an activity, with low-probability, high-consequence risk, brings complex burdens which the public may not easily accept.

SHORT-TERM VERSUS LONG-TERM RISKS/BENEFITS

Washington coastal economies, today and historically, are vitally linked to industries that depend on renewable natural resources of the area. Oil and gas development on the OCS area would, however, be transitory. A producing platform normally reaches the shutdown phase in about 30 years. Of course, the more producing fields, the longer the industry lasts. Once the

Figure 6.2 Wilderness Coast. A wilderness coast offers man a spiritual experience—the eternal universe, the rhythm of life, the vastness of space, the untamed forces, the sweeping power, the conflicting warriors, the unknown plan, the cleansing solace, the misty spirit are there. (Photo: Carolyn Pendle, ORAP)

resource is gone, the industry is gone, although improved recovery techniques sometime renew industry interest. Consequently, any decisions about OCS oil and gas should have information available on long-term versus short-term effects, risks, and benefits. All other things being equal, the resource base that supports the continuing economy of the Washington coastal region should pass relatively unimpaired through any transitory periods of alternate development (Figure 6.2).

UNEVEN DISTRIBUTION OF RISKS/BENEFITS

Further complicating the picture for offshore oil and gas development is the uneven distribution of risks and benefits. The basic primary hazards from petroleum development (blowouts and spills) impact relatively few people--those closest to the casualty. People who depend on the water, such as fishermen, are particularly at risk. Secondary impacts--the need for increased local services (infrastructure) and for local planning--also affect those closest to the development.

On the other hand, the benefits accrue on a much broader scale. Primary beneficiaries are the nation (national security, income, energy independence), the people of the nation (fuel to run their cars and heat their houses), the national and state treasuries, and the industry shareholders and employees (profit and income). While oil and gas leasing will result in revenue for state and local governments, studies of past experience in areas of offshore development have shown few long-range financial benefits to a local community or county like Kenai, Alaska, or Ventura County, California. In light of these equity issues, decision makers within local areas must be well prepared to represent local interests.

CONCLUSION

To deal with offshore oil and gas issues, the local, tribal, and state authorities in Washington must diligently work to catch up with the knowledge, mission, and procedures of the federal process and private industry. They need to develop their own predictable process for managing the issues. To do this, they must become informed about the industry and the OCS lease sale process. At the same time, they must carefully evaluate their own local concerns and needs. To make effective decisions, they need appropriate, sound, thorough, and unbiased information.

The Ocean Resources Assessment Program Advisory Committee has completed its process and presents these information priorities to Washington Sea Grant for use in developing a plan for future studies. These topics are critical to Washington's decision-making on OCS oil and gas activities.

Appendices

APPENDIX A

Engrossed Substitute Senate Bill No. 5533 As Amended By the House

State of Washington • 50th Legislature • 1987 Regular Session

By the committee on Natural Resources (originally sponsored by Senators DeJarnatt, Bluechel, Owen, Zimmerman, Bottiger, Kiskaddon, Conner, Nelson, Tanner, Moore, Rinehart, Williams and Garrett)

Read first time 3/5/87.

An ACT Relating to the preparation of an ocean resources assessment; and creating new sections.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF WASHINGTON

NEW SECTION. SEC. 1. THE LEGISLATURE FINDS THAT:

(1) The marine waters off Washington's coast and the shorelands in proximity to the Pacific Ocean contain human, environmental, and natural resource values which are important to Washington citizens and businesses, and which should receive full consideration prior to any decision to lease portions of the outer continental shelf for oil and gas exploration and development;

(2) These resources include those related to recreational development, commercial fisheries development and management, effective use of coastal communities, ports and harbors, and the beneficial use and protection of shorelands and marine waters;

(3) The United States department of the interior, mineral management service, is planning to conduct a sale of oil and gas lease tracts off Washington's coast in 1991[1] ;

(4) The Mineral Management Service will sponsor studies beginning in 1989 to gather human, environmental, and resource information for their environmental impact statement, and they will ask Washington state for guidance and suggestions on particular topics of study;

(5) In other offshore regions of the United States, the lack of scientific information has impaired the ability of coastal states to direct oil and gas activity to those areas where the potential benefits are greatest and the environmental risks the least significant. A comprehensive scientific understanding of coastal and marine resources will enhance efforts to protect vital state interests;

[1] The correct date is now April 1992.

(6) The state of Washington must begin in 1987 to conduct a review of existing data, studies and expertise about the marine waters off Washington's coast and the shorelands in proximity to the Pacific Ocean, in order to select the best topics for study to be sponsored by the Mineral Management Service; and

(7) The information collected and analyzed will be useful to the economic development and marine resource protection interests of the state.

NEW SECTION. SEC. 2

The director of the Washington state Sea Grant Program shall administer the ocean resources assessment for Washington to conduct a comprehensive synthesis and analysis of existing data, studies, and expertise about human, environmental, and natural resource values that are associated with, and potentially affected by, an oil and gas lease sale on the outer continental shelf adjacent to the coast of Washington; and, to identify gaps in knowledge, and research plans to fill those gaps, that should occur before leasing takes place. To assist the director of the Washington State Sea Grant Program in establishing priorities for the ocean resources assessment, an advisory group consisting of representatives of the Senate and the House of Representatives, the state departments of ecology, agriculture, natural resources, parks and recreation, fisheries, game, trade and economic development, community development and tribal authorities, as well as a citizens' group, is created.

NEW SECTION. SEC. 3.

The director of the Washington Sea Grant Program shall select particular investigators to perform the assessment through submission of proposals and a peer-review selection process that will be open to any qualified individual. The tasks to be undertaken and the criteria for proposal submission and review shall be determined by the provisions of this act and by the director of the Washington Sea Grant Program in consultation with tribal nations and the state departments of ecology, agriculture, parks and recreation, trade and economic development, natural resources, fisheries, game, and community development.

The synthesis and analysis shall result in maps and technical reports summarizing relevant information and synthesizing existing data, and it shall result in a detailed plan for studies to address human, environmental, and natural resources issues related to outer continental shelf leasing.

NEW SECTION. SEC. 4.

The director of the Washington Sea Grant Program shall submit the assessment to the 1989 legislature on the results of the information gathered by the investigators.

The assessment shall consider topics of potential use in the Minerals Management Service environmental impact statement and shall include, as a minimum, the following:

(1) Socioeconomic studies such as recreational and fisheries development, use of ports and shorelands, Indian treaty rights, fishing patterns and management plans, oil-spill contingency planning, and multiple-use conflicts;

(2) Water column and biological studies such as primary productivity, circulation, hydrography and nutrients, plankton and benthos, crabs, shrimp, groundfish, pelagic and anadromous fish, seabirds, and mammals; and

(3) Environmental quality studies assessing issues such as biogeochemistry, pollutants, transport of drilling muds and oil, and fish behavior.

The director of the Washington Sea Grant Program may issue periodic reports to the governor and the legislature.

Passed the Senate April 21, 1987

Passed the House April 15, 1987.

Approved May 18, 1987.

Effective July 26, 1987.

APPENDIX B

Charge to Advisory Committee to the Washington Sea Grant Ocean Resources Assessment Program

February 29, 1988

BACKGROUND

The legislation which established the Ocean Resources Assessment Program (ORAP) calls for an advisory committee, including state legislators, agency officials, and leaders of several interested public and private organizations.

COMMITTEE PURPOSE

The advisory committee exists to help WSG identify information gaps and research needs for Washington state.

APPROACH

The advisory committee, building from the breadth of experience and expertise of its members, can uniquely investigate the situations Washington state would face if the MMS sale proceeds.

The state's actual information gaps and research needs would depend greatly on what types of operations, equipment, and facilities would be used onshore and offshore by industry, during all phases of oil and gas extraction. Thus a successful study must tap diverse sources of data and information about industry operations, equipment, and facilities, while not presupposing state policy alternatives about whether and how to encourage, discourage, or control oil and gas leasing. To do this, the committee will conduct case studies of hypothetical exploration, development, production, and distribution scenarios for oil and gas off the Pacific coast of Washington.

The ORAP advisory committee will complete these following tasks:

- Define hypothetical scenarios for exploration, development, production, and distribution for oil and gas off the Pacific coast of Washington.
- Conduct tours of existing sites, vessels, and facilities in- and out-of-state where operations and plans are relevant to the cases under study.
- Conduct meetings and attend appropriate conferences and workshops to increase understanding of cases.

- Gather and present to the committee data, information, maps, and photographs, etc.
- Examine present laws, ordinances, and regulations to determine what information would be required to process necessary EIS(s) for the cases.
- Determine whether adequate information exists for such EISs, and, if information is inadequate, identify the types and levels of detailed information that might be required of permit applicants seeking to implement the cases.
- From the cases, identify key issues, policy questions, information gaps, and research needs facing Washington state due to potential OCS development.
- Report the findings to Washington Sea Grant.

Committee Member Responsibilities

- Attend full-committee meetings (about three).
- Attend about two in-state meetings of subcommittees and one out-of-state trip. (Total travel involved would include approximately five in-state and one out-of-state trips.)
- Submit a written trip report for each trip taken, summarizing for the committee the information gathered.
- Subcommittees will be responsible to develop written and oral reports to the full committee.
- The committee will contribute to and review its report to WSG.

APPENDIX C

Subcommittee Assignments

EXPLORATION	Senator Arlie DeJarnatt Jim Harp* H.F. (Lin) Hazel David McCraney Ernie Summers Representative Sim Wilson
OFFSHORE	Senator Alan Bluechel Coleman Ferguson Keith Herrell Bill Lawrence Judith Merchant** Senator Jack Metcalf Bob Petersen Chris Platt** Representative Dean Sutherland
ONSHORE	Representative Bob Basich Sandi Benbrook** Bob Chase Chris Drivdahl Bill Fitch Representative Mary Margaret Haugen Cleve Pinnix** Mike Schwisow Tim Trohimovich Senator Hal Zimmerman
TRANSSHIPMENT	Representative Gary Bumgarner Craig Partridge Commissioner Robert Paylor Fred Piltz Senator Bill Smitherman* Dave Sones

*Subcommittee Chair
**Co-chair

APPENDIX D

Sites Visited—1988

Destination	Facility/Vessel/Subj	Contact	Dates
SUBCOMMITTEE: EXPLORATION			
GROUP A:			
Houston	Blowout preventer manufacture	Cameron Iron Wks.	16 May
Houston	Oil well firefighting	Boots & Coots	16 May
Houston	Seismic surveying	Exxon USA	16 May
Galveston	*Rowan Midland* (semi-submersible)	Rowan Companies	17 May
Louisiana (Offshore)	*Rowan Gorilla III* (jackup rig)	Rowan Companies	17 May
Sabine Pass	*BAR 323* (pipelay barge)	Brown & Root USA	17 May
Sabine Pass	*BAR 280* (bury barge)	Brown & Root USA	17 May
Houston	Seabed stabilization	Seabed Scour Control Systems	18 May
Houston	Seismic surveying	Western Geophysical	18 May
Santa Barbara*	Offshore pipelines	Texaco Trading & Transportation	19 May
Santa Barbara*	Oil & gas—fishing industries coexistence	Calif. Sea Grant Calif.Coastal Operators Group, various commerical & sport fishermen	19-20 May
GROUP B:			
Ventura	Drilling muds supplier	NL Baroid/N.L. Industries	10 May

Destination	Facility/Vessel/Subj	Contact	Dates
Oxnard (Offshore)	*SEDCO 712* (semisubmersible)	SEDCO	10 May
Santa Barbara	Discussion on drilling muds	Two UCSB faculty members	11 May
Santa Barbara	Mediation: fisheries—oil & gas industry conflict resolution; Eggs & Larvae Cmttce	Calif. Sea Grant, Calif. Coastal Operators Group, & Mediation Inst.	11 May
Santa Barbara	Commercial fishing in S.B. Channel	Calif. Sea Grant & various commercial fishermen	11 May
Santa Barbara	County role & experience	Santa Barbara Cnty. Energy Div., Res. Mgmt. Dept.	11 May
Santa Barbara	Marine environment	Sea Center, Mus. of Nat. History	11 May
Oxnard (Offshore)	*Indian Seal* (seismic vessel)	Geophysical Service Inc & Intl Assoc of Geophysical Contractor	12 May

SUBCOMMITTEE: OFFSHORE

GROUP A:			
Santa Barbara	Citizens' groups	Get Oil Out (GOO)	13 April
Santa Barbara	Commercial fisheries—oil industry liaison	Calif. Coastal Operators Group	13 April
Santa Barbara	Commercial fishermen	Calif. Sea Grant	13 April
Santa Barbara	Marine mammals	Mus. of Nat.Hist.	14 April
Carpinteria/ Port Hueneme	*Mr. Clean III*	Clean Seas	14 April
Ventura	Channel Is. Natl. Park	DOI	14 April

Destination	Facility/Vessel/Subj	Contact	Dates
Santa Barbara	Channel Is. Natl. Marine Sanctuary	NOAA	14 April
Offshore S.B./ Ventura	Platform Gail	Chevron	5 April
Goleta	Natural oil seeps off Coal Oil Point	UCSB	15 April
GROUP B:			
Offshore Long Beach	BETA offshore production facilities	Shell E&P	17 May
Offshore Long Beach	THUMS (artificial islands)	Shell E&P	7 May
Offshore Pt. Arguello	Platform Irene	UNOCAL	18 May
Lompoc	HS&P processing facil.	UNOCAL	18 May
Santa Barbara	Citizen participation	Cit.'s Planning Assn.	18 May
Santa Barbara	Recreational fisheries	Calif. Sea Grant & various fishermen	18 May
Ventura	County role & experience	Planning Div., Ventura Cnty.	19 May
Ventura	Monitoring long-term platform impacts on biol. communities	Battelle Ocean Sciences	19 May
Santa Barbara	State legislative role & experience	Staff to Calif. State Sen. Gary Hart	19 May
GROUP C:			
Sacramento*	State agency roles & experience	Calif. Fish & Game Dept, State Lands Cmsn., & Office of Offshore Devel.	17 May

Destination	Facility/Vessel/Subj	Contact	Dates

SUBCOMMITTEE: ONSHORE

GROUP A:

Anchorage	State agency roles & experience	AK Depts. of Community & Regional Affairs; Fish & Game, & Natural Resources	18 May
Anchorage	Oil spills	U.S. Coast Guard	19 May
Cook Inlet	Platform Granite Point	UNOCAL	19 May
Nikiski	LNG plant	Phillips/Marathon	19 May
Nikiski	Ammonia/urea plant	UNOCAL	19 May
Kenai	Wildlife and oil devel.	Kenai Wildlife Refuge	19 May
Kenai	Commerical fisheries	Alaska Sea Grant, Cook Inlet Aquaculture Assn., Upper Cook Inlet Drifters Assn., & Kenai Peninsula Cooperative	20 May
Kenai	Local business interests	Kenai Chamber of Commerce	20 May
Kenai	Borough role & experience; planning	Kenai Borough Mayor & Planning Dept.	20 May
Kenai	Native peoples' impacts	Salamatof Natives Assn. & Kenai Natives Assn.	20 May
Kenai	Wildlife/birds	Ducks Unlimited	21 May
Kenai	State legislative role & experience	Former state rep. & current Kenai assemblyman Pat O'Connell	21 May

Destination	Facility/Vessel/Subj	Contact	Dates
Group B:			
Goleta	Ellwood separation & treatment plant	ARCO	31 May
Goleta	Air quality impacts of oil barge operations	UCSB Coal Oil Point Reserve	31 May
Santa Barbara	County role & experience	Resource Mgmt. Dept., S.B. Cnty.	31 May
Ventura	National park & marine sanctuary	Channel Islands Natl. Park	1 June
Port Hueneme	Supply base & vessels	Oxnard Harbor District & vessel operator	1 June
Santa Barbara**	Local governance of offshore oil & gas	UCSB faculty, S.B. Cnty. Res. Mgmt. Dept., Area Planning Council, & Ch. Is. Natl. Marine Sanctuary	1 June
Santa Barbara	UCSB perspective on proposed ARCO Coal Oil Point Project	UCSB environ. health & safety administrator	2 June
Santa Barbara	Santa Ynez Unit: Platform Hondo, OS&T, & future expansion	Exxon USA	2 June
Gaviota*	Gaviota Oil & Gas Processing Plant	Chevron USA	2 June
GROUP C:			
San Francisco	Studies for central Calif. counties	Chabot Associates	16 June
Sacramento	State agency roles & experience	Calif. Coastal Cmsn., State Lands Cmsn., & Office of Offshore Development	16 June

Destination	Facility/Vessel/Subj	Contact	Dates
SUBCOMMITTEE: TRANSSHIPMENT			
San Pedro	*The Oregon* (oil tanker)	Chevron Shipping	31 May
Long Beach	Marine safety/ oil spills/dispersants	U.S. Coast Guard	31 May
Los Angeles	OCS leasing & environ. studies	Minerals Mgmt. Svc.	31 May
Gaviota	Marine terminal	Texaco Trading & Transportation	1 June
Carpinteria & S.B. Harbor	Oil spill cleanup	Clean Seas	1 June
Goleta**	Local governance of offshore oil & gas	UCSB faculty, S.B. Cnty.Res.Mgmt. Div.& Area Planning Council, & Ch.Is.Natl. Marine Sanctuary	1 June
S.B. Harbor	Pipelines	Self-guided	2 June
Santa Barbara	Citizen participation	Cit.'s Planning Assn.	2 June
Santa Barbara	State legislative role & experience	Staff to Calif. State Sen. Gary Hart	2 June
Santa Barbara	Emergency mgmt. & response	S.B. Cnty. Office of Disaster Preparedness	2 June

NOTES:

* This portion of the trip was made by one member of the subcommittee.

** Joint meeting of members of the Onshore and Transshipment subcommittees.

APPENDIX E

Selected, Relevant Research Projects

Title or Subject	Performed by	Sponsor	Approx. Amount	Ended or Due
Summary/Analysis of Environ. Info.-Ore./Wash. Coastal /Offshore	Oceanographic Institute of Washington	BLM (Pacific)	$160,000	8-77
The Oregon Oceanbook	DLCD	DLCD & Ore. Sea Grant	$60,000	1985
OCS Policy Study	Cogan, Sharpe, Cogan (Portland, Ore.)	Wash. Dept. of Ecology	$30,000	6-86 (Rev. 7-11-86)
Oregon Territorial Sea Mgmt. Study	OSU & Univ. of Ore.	DLCD & Ore. Sea Grant	$34,300	6-30-87
Review of Environ. Studies Program:	BEST Panels	MMS (Hdqtrs)	$2,000,000	
a) Physical oceanography				3-89
b) Ecology				10-89
c) Socio-economics				1-90
Air Quality Modeling: OCS Lease Sales 128, 132, & 138	Contractor to be selected	MMS (Pacific)	To be determined	3-91?
Coastal Circulation along Wash.& Ore.	Envirosphere Co. (Bellevue, Wash.)	MMS (Pacific)	$133,500	10-88
Interannual Variability of Oceanographic Conditions & Circulation along Wash./Ore. Coast	Contractor to be selected	MMS (Pacific)	To be determined	10-92?

Title or Subject	Performed by	Sponsor	Approx. Amount	Ended or Due
Summary & Data Base of Wash./ Ore.Coastal Ecology	Contractor to be selected	MMS (Pacific)	To be determined	10-91?
Synthesis of Knowledge of Potential Impacts from OCS Oil & Gas Activities on Fisheries	Technical Resources, Inc. (Rockville, Md.)	MMS (Atlantic)	$318,842	10-89
Review of Three Oil Spill - Fisheries Interactive Models	MMS Scientific Cmttee. & TRI (above)	MMS (Hdqtrs)	$150,000	3-89
Adaptation of Marine Organisms to Chronic Hydrocarbon Exposure	Kinnetic Laboratories, Inc. (Santa Cruz, Calif.)	MMS (Pacific)	$961,738	1-90
Economic Impacts and Net Economic Values Associated with Non-Indian Salmon & Sturgeon Fisheries	ICF Technology, Inc. (Redmond, Wash.)	DCD	$118,000	3-88
Management of Living Marine Resources: Research Plan for Wash./Ore. Continental Margin	ODFW	NCRI (Newport, Ore.)	$120,000	12-88?
Wash./Ore./ Calif. OCS Fisheries Resource Data Base	PMFC, ODFW, WDF, NWIFC, & EcoAnalysis, Inc. (Ojai, Calif.)	MMS (Pacific)	$448,509	10-92

Title or Subject	Performed by	Sponsor	Approx. Amount	Ended or Due
Fish Assemblages of Rocky Banks of Pac. NW	OSU	MMS (Pacific)	$487,439	8-91
Evaluation of Spawning & Recruitment Patterns of Wash./Ore./N. Calif. Commercial Fishes	NMFS, Seattle, & OSU	MMS (Pacific)	$288,260	7-90
Effects of Acoustic Air-guns on Zoae Larval Stage of Dungeness Crab	Battelle Ocean Sciences (Ventura, Calif.)	Eggs & Larvae Committee, Calif Dept. of Fish & Game, et al.	$440,000	1-89
Marine Mammal/ Seabird Surveys of Ore./Wash.	Envirosphere Co. (Bellevue, Wash.)	MMS (Pacific)	$1,484,586	3-91
Baseline Socio-Economic Profile of 15 Wash/Ore. Coastal Counties	Kearney/ Centaur Div., (Wash., D.C.)	MMS (Pacific)	$180,000	1-89
Calif./Ore./ Wash. Archaeological Resource	Contractor to be selected	MMS (Pacific)	To be determined	To be determinded
Inventory/Evaluation of Wash./ Ore. Coastal Recreation Resources	National Park Service & UW	MMS (Pacific)	$213,000	4-91
Potential Social & Economic Effects of OCS Oil & Gas Activities on Ore. & Wash. Indian Tribes	Contractor to be selected	MMS (Pacific)	To be determined	To be determined

APPENDIX F

Acronyms and Abbreviations

This list of acronyms and abbreviations was assembled using a variety of sources. The primary sources include:

Managing Oil and Gas Operations on the Outer Continental Shelf, by the U.S. Department of the Interior/Minerals Management Serivce.

Leasing Energy Resources on the Outer Continental Shelf, by the U.S. Department of the Interior/Minerals Management Service.

Introduction to Oil and Gas Production, by the Executive Committee on Training and Development, American Petroleum Institute. Copyright 1983 by the Production Department, American Petroleum Institute, Dallas, Texas. Used by permission of the publisher.

ACT	Automatic Custody Transfer
APCD	Air Pollution Control District
API	American Petroleum Institute
APD	application for permit to drill, deepen, or plug back
ASBS	area of special biological significance
BAST	best available and safest technologies
BCF	billion cubic feet
B/D	barrels per day; also BPD
BOPD	barrels of oil per day
BWPD	barrels of water per day
BLPD	barrels of liquid per day
BEST	Board of Environmental Studies and Toxicology
BLM	Bureau of Land Management
BOE	barrel of oil equivalent
BOP	blowout preventer

BPCD	barrels per calendar day
BS&W	basic sediment and water
BTU	British Thermal Unit
C/COG	California Coastal Operators Group
CEQ	Council on Environmental Quality
Cfd	cubic feet per day
CFR	Code of Federal Regulations
CIDS	concrete island drilling system
COE	U.S. Army Corps of Engineers
COFS	College of Ocean & Fishery Sciences, UW
COST	continental offshore stratigraphic test
CPUE	catch per unit of effort
CVA	certified verification agent
CZM	Coastal Zone Management
DCD	Washington Department of Community Development
DLCD	Oregon Department of Land Conservation and Development
DEIS	Draft Environmental Impact Statement
DNR	Washington Department of Natural Resources
DOC	U.S. Department of Commerce
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior

DOJ	U.S. Department of Justice
DOT	U.S. Department of Transportation
DPP	Development and Production Plan
DST	deep stratigraphic test or drill stem test, depending on context
DWT	deadweight tons
EA	Environmental Assessment
Ecology	Washington Department of Ecology
EEZ	Exclusive Economic Zone
EFSEC	Washington Energy Facility Site Evaluation Council
EFT	electronic funds transfer
EIS	Environmental Impact Statement
EOR	enhanced oil recovery
EPA	U.S. Environmental Protection Agency
ER	Environmental Report
FDP	Final Development Plan
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
FY	fiscal year
FWS	U.S. Fish and Wildlife Service
FONSI	finding of no significant impact
GHRPC	Grays Harbor Regional Planning Commission
GOR	gas-oil ratio

GLR	gas-liquid ratio
H_2S	hydrogen sulfide
ICC	Interstate Commerce Commission
INC	incident of noncompliance
IP	initial potential
LACT	Lease Automatic Custody Transfer; also ACT
LNG	liquefied natural gas
LPG	liquefied petroleum gas
Mbpd	thousand barrels (of oil) per day
Mcf	thousand cubic feet (usually applied to natural gas)
MER	maximum efficient rate
MMBBL	million barrels
MMbpd	million barrels (of oil) per day
MMS	Minerals Management Service
MOU	memorandum of understanding
MPCH	marginal probability of commercial hydrocarbons
MPR	maximum production rate
Mscfd	thousand standard cubic feet per day
NCRI	National Coastal Resources Research & Development Institute
NEPA	National Environmental Policy Act
NGL	natural gas liquids
NGPA	Natural Gas Policy Act

NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Survey
NO_x	nitrogen oxides
NPDES	National Pollution Discharge Elimination System
NPS	U.S. National Park Service
NRC	National Research Council
NTL	Notice to Lessees and Operators
NWIFC	Northwest Indian Fisheries Commission
OCS	outer continental shelf
OCSIP	Outer Continental Shelf Information Program
ODFW	Oregon Department of Fish and Wildlife
OHMSETT	Oil and Hazardous Materials Simulated Environmental Test Tank
OMM	Offshore Minerals Management
OPD	official protraction diagram
ORAP	Ocean Resources Assessment Program
OSHA	U.S. Occupational Safety and Health Administration
OSU	Oregon State University
OS&T	offshore storage and treatment
P&A	plug and abandon
PDP	Preliminary Development Plan

PINC	potential incident of noncompliance
PFMC	Pacific Fishery Management Council
POE	Plan of Exploration
PSI	pounds per square inch
RM or RMP	Royalty Management Program
RTWG	regional technical working group
Scfd	standard cubic feet per day
St Parks	Washington State Parks and Recreation
SID	secretarial issue document
SPM	single point mooring
TAP	Trans-Alaska Pipeline
Tcfd	trillion cubic feet per day
TLP	tension leg platform
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
UW	University of Washington
WDF	Washington Department of Fisheries
WDW	Washington Department of Wildlife
WSG	Washington Sea Grant

APPENDIX G

Glossary

The five primary sources for this glossary were:

Introduction to Oil and Gas Production, by the Executive Committee on Training and Development, American Petroleum Institute. Copyright 1983 by the Production Department, American Petroleum Institute, Dallas, Texas. Used by permission of the publisher. (Note: This book is intended for basic orientation and training purposes, and its glossary does not necessarily represent "standard" definitions.)

Managing Oil and Gas Operations on the Outer Continental Shelf, by the U. S. Department of the Interior/Minerals Management Service.

Leasing Energy Resources on the Outer Continental Shelf, by the U.S. Department of the Interior/Minerals Management Service.

Introduction to the Oil Pipeline Industry, by the Petroleum Extension Service (PETEX), Division of Continuing Education, The University of Texas at Austin.

Kennedy, John L. *Fundamentals of Drilling—Technology and Economics*. Tulsa, Oklahoma: PennWell Publishing Co., 1983.

Abandon—To cease efforts to produce oil or gas from a well, and to plug a depleted formation and salvage all material and equipment.

Absorption—To soak up as a sponge takes water.

Acidizing—The treatment of formations with hydrochloric or other type acids in order to increase production or injection.

Adsorption—The attraction exhibited by the surface of a solid for a liquid or a gas when they are in contact.

Affected State—This term is defined in specific detail in the OCS Lands Act, as amended (Section 1331(f)). For our purposes, the term is defined briefly as follows.

(1) For actions pursuant to the OCS Lands Act: a State which is or may be affected by activities on the OCS. In common usage, "Affected State" means the State(s) identified by the Secretary of the Interior for consultation on OCS leasing.

(2) For actions pursuant to the CZM Act: a State whose land and water use in the coastal zone are affected by an OCS permit and/or an exploration or a development and production plan.

Aliphatic—A straight-chair hydrocarbon; if the molecules are saturated with hydrogen they are called parafins and are very stable (e.g. ethone, propane), unsaturated hydrocarbons are called olefins (e.g. ethylene and propylene).

Allowable—The amount of oil or gas that a well is authorized by the state regulatory agency to produce during a given period.

Annular Space—The space around a pipe (casing or tubing) suspended in a wellbore is often termed the annulus, and its outer wall may be either the wall of the borehole or the casing.

APCD—Air Pollution Control District. A local agency operating under the State Air Resources Board. Each District is responsible for regulating air emissions and developing air quality maintenance plans to guide new development within their basin, consistent with the guidelines and standards set forth in the Federal Clean Air Act.

API—Abbreviation for American Petroleum Institute, with headquarters in Washington, D.C. This is the trade association for the petroleum industry.

API Gravity—The standard adopted by API for measuring the density of a liquid, expressed in degrees. It can be converted from specific gravity by the following equation:

$$\text{Degrees API gravity} = \frac{141.5}{\text{Specific gravity}} - 131.5$$

Aquifer—A water-bearing rock stratum. In a water-drive field the aquifer is the water zone of the reservoir underlying the oil zone.

Area Adjacent to a State—All of that portion of the OCS which is included within a planning area if such planning area is bordered by that State or is deemed by 30 CFR 252.2 to be adjacent to that State.

Area of Hydrocarbon Potential—An area which has the primary geologic characteristics favorable for the generation and the accumulation of hydrocarbons.

Aromatic—Having a basic chemical composition and structure of six carbon atoms in a ring. Aromatic hyrdocarbons include benzone, toluene, and xylene.

Associated Gas—Natural gas which is in contact with crude oil in the reservoir.

Automatic Custody Transfer (ACT)—See "Lease Automatic Custody Transfer."

Automation—The automatic, self-regulating control of equipment, systems, or processes.

Back Pressure—The pressure resulting from restriction of full natural flow of oil or gas.

Bad Oil—Oil not acceptable for delivery to the pipeline purchaser because of too high BS&W; oil requiring additional treating.

Baffles—Plates or obstructions built into a tank or other vessel to change the direction of fluid flow.

Barrel—Forty-two gallons (U.S.).

Basic Sediment and Water (BS&W)—The water and other extraneous material present in crude oil.

Batch—A definite amount of oil, mud, chemicals, cement, or other material in a treatment or operation.

B/D—The abbreviation for barrels per day. Other related abbreviations are:

BPD for barrels per day
BOPD for barrels of oil per day
BWPD for barrels of water per day
BLPD for barrels of liquid per day

Benthic—Relating to or occurring at the bottom of a body of water, including the ocean.

Bid—An offer for an OCS lease submitted by a potential lessee in the form of a cash bonus dollar amount or other commitments as specified in the final notice of sale.

Bidding System—A combination of terms and conditions under which a bid is submitted. The economic terms include, but are not necessarily limited to, (1) the minimum bid per acre, (2) the yearly rental, (3) profit share rates imposed on future production from those tracts leased. See "Royalty."

Bidding Unit—All unleased Federal portions of 2 or more blocks whose combined acreage is 5,760 acres or less which is offered in a specific lease sale as a single leasable entity. See "Tract."

Blank Off—To close off by sealing or plugging.

Bleed—To drain off liquid or gas, generally slowly, through a valve called a bleeder. To bleed down, or bleed off, means to slowly release the pressure of a well or of pressurized equipment.

Block—A numbered area on an OCS leasing map or official protraction diagram. (See "OCS Leasing Maps and Official Protraction Diagrams.") Blocks are portions of OCS leasing maps and official protraction diagrams that are themselves portions of planning areas. Blocks vary in size, but typical ones are 5,000 to 5,760 acres (approximately 9 square miles). Each block has a specific identifying number, area, and latitude and longitude coordinates that can be pinpointed on a leasing map or official protraction diagram. See "Tract."

Blowout—An uncontrolled flow of gas, oil, or other fluids from a well to the atmosphere. A well may blow out when formation pressure exceeds the pressure overburden of a column of drilling fluid.

Blowout Preventer (BOP)—The equipment installed at the wellhead for the purpose of controlling pressures in the annular space between the casing and drill pipe (or tubing) during drilling, completion and certain workover operations;[1] an assembly of heavy-duty valves attached to the top of the well casing to control well pressure (also known as a "stack").

Bonus—Advance money offered by a bidder for the right to be awarded an oil and gas lease.

Borehole—A hole drilled in the earth's crust.

Bottom-Hole—The lowest or deepest part of a well.

Bottom Water—Water occurring below the oil and gas in a production formation.

Break Out—To unscrew one section of pipe from another section.

Brine—Water that has a large quantity of salt, especially sodium chloride, dissolved in it. Salt water.

Bring In A Well—To complete a well and put it in production.

BTU (British Thermal Unit)—A measure of the heating value of a fuel.

Cap Rock— An impermeable rock overlying an oil or gas reservoir that tends to prevent migration of fluids from the reservoir.

Cased Hole—A wellbore in which casing has been run.

Cash Bonus—See "Bonus."

Casing—A steel pipe placed in a borehole to maintain the hole during drilling, to protect against high-pressure reservoirs, and to provide a means of extracting oil and gas.

Casinghead Gas—Associated and dissolved gas produced with crude oil; oil well gas.

Casing String—The pipe run in a well, for example: surface string, intermediate string, production string, etc.

Categorical Exclusion—A category of actions which do not individually or cumulatively have a significant effect on the human environment and which have been found to have no such effect in procedures adopted by a Federal Agency in implementation of the NEPA regulations and for which, therefore, neither an EIS nor an EA is required.

Cat Walk— A narrow walkway.

Check Valve—A valve which permits flow in one direction only.

Choke—A type of orifice installed for the purpose of restricting and controlling flow.

Christmas Tree—The assembly of valves, pipes, and fittings used to control flow of oil and gas from the well.

Closed In—A well capable of producing oil or gas, but temporarily shut in.

Coastal Zone—Coastal waters and the adjacent shorelands strongly influenced by each other. Note: the term, "Coastal Zone" has a special meaning when the word is used in the context of CZM programs. When used in that context, "Coastal Zone" means State coastal waters and adjacent lands identified by a State in its approved CZM program.

Coastal Zone Consistency Review—Review of Federal licenses or permits and OCS plans pursuant to the CZM Act by affected coastal States to determine if the action is consistent with the State-approved CZM program.

Collar—Heavy joints of drill pipe directly above the bit, which add pressure on the bit.

Commingling—(1) Mixing of hydrocarbons in common-carrier pipelines when one company's production facility is closer to another company's refinery than to its own, or vice versa. Also used to facilitate transportation or to blend oils for composition requirements. (2) During an exploration, commingling refers to mixing of formation fluids from two separate reservoirs by flow through a bore hole, which may result in permanent damage to potable aquifers (Washington Administrative Code 344-12-087(b)).

Come Out Of The Hole—To pull drill pipe, tubing, wireline tools, etc., out of the well.

Completion—See "Well Completion."

Compliant Platform—Unlike a rigid, pile-fixed platform that resists sea forces, a compliant platform is built to sway or "comply" with them. Varieties of compliant platforms include the guyed tower, buoyant tower, flexible tower, compliant piled tower, and tension leg platform.

Conclusively Presumed—Assumed to be concurred in. The term relates to the concurrence by a State in an applicant's consistency certification for a plan of exploration or a plan of development and production. If a State does not comply with the time requirements of the CZM Act to notify appropriate officials of its concurrence with or objection to an applicant's certification, the MMS can presume that the State concurred with it. See "Coastal Zone Consistency Review."

Condensate—(1) Hydrocarbons which are in the gaseous state under reservoir conditions but which become liquid either in passage up the hole or in the surface equipment. (2) Liquid hydrocarbons produced with natural gas which are separated from the gas by cooling and various other means.

Conditional Resources—The amount of oil or gas expected to be found in an area, on the condition that commercial (economically recoverable) quantities of oil and gas are present.

Consistency Review—As called for in the CZM Act the plans for a process of review to determine if an action is consistent with the State-approved CZM program.

Continental Margin—The zone separating the emergent continents from the deep sea bottom.

Continental Shelf—A broad, gently sloping, shallow feature extending seaward from the shore to the continental slope.

Continental Slope—The submerged, steeply sloping portion of the continental margin, seaward of the continental shelf.

Control Panel—Switches and devices to start, stop, measure, monitor or signal what is taking place.

Crude Oil—A mixture of liquid hydrocarbons that exists in natural underground reservoirs and remains liquid at atmospheric pressure after passing through surface separating facilities but does not include liquid hydrocarbons produced from tar sand, gilsonite, oil shale, or coal. Crude oil ranges from very light (high in gasoline) to very heavy (high in residual oil). Sour crude is high in sulphur content.

Cumulative Impact—Two or more individual effects which, when considered together, are considerable, or which compound or increase other environmental impacts. The individual effects which may result in cumulative impacts may be changes resulting from a single project or a number of separate projects. The cumulative impact from several projects is the change in the environment which results from the incremental impact of the project when added to the other closely related past, present and reasonably foreseeable probably future projects taking place over a period of time (CEQA, 15355).

Cut Oil—Oil that contains water, usually in the form of an emulsion. Also called "wet oil".

D&P Platform—A drilling and production platform. Such an offshore platform is a large structure with room to drill and complete a number of wells.

Dead Oil—Crude oil containing essentially no dissolved gas when it is produced.

Dead Well—A well which has ceased to produce oil or gas, either temporarily or permanently.

Debug—To detect, locate and correct malfunctions in a computer, instrumentation or other type system.

Delineation Well—A well that is drilled to determine the extent of a reservoir.

Density—The weight of a substance per unit of volume. For instance, the density of a drilling mud may be described as "10 lb per gallon" or "75 lb per cubic foot."

Derrick—The tower-like component of a drilling rig that supports the cables and blocks which in turn raise and lower the drill stem and bit.

Development and Production Plan—A plan submitted by industry to MMS for approval Production Plan which describes activities beyond exploration until the lease expires. The activities include facility installation, drilling and production, etc.

Development Phase—Activities following exploration, discovery, and delineation of minerals, including geophysical activities, drilling, platform construction, and construction and operation of directly related onshore support facilities for commercial production purposes.

Development Well—A well drilled in proven territory in a field for the purpose of completing the desired spacing pattern of production.

Discovery—The initial find of significant quantities of fluid hydrocarbons on a given field on a given lease.

Discovery Well—An exploratory well that encounters a new and previously untapped petroleum deposit. A successful "wildcat well".

Dispersants—Specially developed solvents that can be applied to oil which has been spilled in a body of water to break up or disperse the surface oil. The oil then forms tiny oil deposits in the water column.

Disposal Well—A well through which water (usually salt water) is returned to subsurface formations.

Dissolved Gas—Natural gas which is in solution with crude oil in the reservoir.

Dogleg—A term applied to a sharp change.

Dolomite—A type of sedimentary rock similar to limestone but rich in magnesium carbonate. Sometimes dolomite is found as the reservoir rock for petroleum.

Dope—A viscous material used on casing or tubing threads as a lubricant, and to prevent corrosion; a tarbase coating for pipelines to prevent corrosion.

Downhole—A term to describe tools, equipment, and instruments used in the wellbore. For example, a downhole tool is used in the wellbore. Also, conditions or techniques applying to the wellbore.

Drawworks—The hoisting mechanism on a drilling rig. It is essentially a large winch that spools off or takes in the drilling line and thus raises or lowers the drill stem and bit.

Drill pipe—Heavy, thick-walled steel pipe used in rotary drilling to turn the drill bit and to provide a conduit for the drilling muds.

Drill ship—A self-propelled, self-contained vessel equipped with a derrick amidships for drilling wells in deep water. It may have a ship hull, a catamaran hull, or a trimaran hull.

Drilling Mud—A special mixture of clay, water, or refined oil, and chemical additives pumped downhole through the drill pipe and drill bit. The mud cools the rapidly rotating bit, lubricates the drill pipe as it turns in the well bore, carries rock cuttings to the surface, serves as a plaster to prevent the walls of the bore hole from crumbling or collapsing, and provides the weight or hydrostatic head to prevent extraneous fluids from entering the well bore and to control the downhole pressures that may be encountered.

Drip—The small quantities of liquid hydrocarbons which sometimes condense in a natural gas line. Also the equipment installed on a gas line to remove liquids.

Dry Gas—Gas that does not contain natural gas liquids and condensable water vapors.

Dry Hole—Any exploratory or development well that does not produce oil or gas in commercial quantities.

Dynamic Positioning—A computer-activated means of maintaining a drillship or semisubmersible on location by continuous activation and control of the normal propulsion system and of specially located propulsion units called "thrusters." Dynamic positioning is normally used in waters too deep to use mooring lines and anchors economically.

Easement— See "Right of Use and Easement."

Economically Recoverable Resource Estimate—An assessment of hydrocarbon potential that takes into account (1) physical and technological constraints on production and, () the influence of costs of exploration and development and market price on industry investment in OCS exploration and production.

Emulsion—A mixture of crude oil and formation water. Generally requires time and heat, chemicals (called demulsifiers or emulsion breakers) or electricity to separate the water from the oil.

Endangered and Rare Species—A species of animal or plant which is in immediate jeopardy from one or more causes, including loss or change of habitat, exploitation, predation, competition, disease or other factors. A species of animal or plant is rare when it is not immediately threatened with extinction but exists in such small numbers that it may become endangered if its environment worsens or if it is likely to become endangered within the foreseeable future throughout all or a significant portion of it range.

Environment—The physical conditions which exist within the areas which will be affected by a proposed project, including land, air, water, minerals, flora, fauna, noise levels, objects of historical and aesthetic significance, and where specified, socio-economic conditions.

Environmental Assessment (EA)—A concise public document required by NEPA. In the document, a Federal Agency proposing an action provides evidence and analysis for determining whether it must prepare an EIS or whether it finds there is no significant impact, i.e., FONSI.

Environmental Impact Statement (EIS)—A statement prepared by a Federal Agency in compliance with NEPA for any major action that could have a significant effect on the human environment.

Exploration Phase—The process of searching for minerals preliminary to development. Exploration activities include (1) geophysical surveys, (2) any drilling to locate an oil or gas reservoir, and (3) the drilling of additional wells after a discovery to delineate a reservoir. It enables the lessee to determine whether to proceed with development and production.

Exploration Plan—A plan submitted by a lessee that identifies all the potential hydrocarbon accumulations and wells that the lessee proposes to drill to evaluate the accumulations within the lease or unit area covered by the plan. All lease operators are required to obtain approval of such a plan by a Regional Director before exploration activities may commence.

Fail Safe—Said of equipment or a system so constructed that, in the event of failure or malfunction of any part of the system, devices are automatically activated to stabilize or secure the safety of the operation.

Fathom—A length of six feet, used as a unit of measure for the depth of water.

Fatigue—Failure of a metal under repeated loading.

Field—A geographical area in which one or more oil or gas wells produce. A field may refer to surface area only or to underground productive formations. A single field may include several reservoirs separated either horizontally or vertically.

Find—A discovery of petroleum that is commercially feasible to produce.

Fire Wall—A dike built around oil tanks, oil pumps and other oil handling equipment to contain any oil which may be accidentally discharged from the equipment. It also serves to block the spread of a fire or give protection for a period of time while emergency action is taken.

Fishing—The effort to recover tools, cable, pipe, or other objects from the wellbore which have become lost in the well accidentally. Many special and ingeniously designed fishing tools are used to recover objects lost downhole. The object being sought downhole by the fishing tools is referred to as the fish.

Fittings—The small pipes and valves that are used to make up a system of piping.

Five-Year Program and Leasing Schedule—A leasing program that consists of a schedule of proposed lease sales indicating, as precisely as possible, the size, timing, and location of leasing activity which the Secretary of the Interior determines will best meet national energy needs for the 5-year period following its approval or reapproval.

Fixed or Bottom Founded—Permanently or temporarily attached to the seafloor.

Fixed Platform/Drilling Tender Combination—A combination of a fixed bottom-founded platform and a floating tender. The platform is permanently attached to the seafloor and carries the essential drilling equipment. The floating tender is temporarily attached to the platform and carries many of the accessories.

Flammable—Highly combustible; easily ignitable.

Flange Up—To finish a job.

Flow String—The string of casing or tubing through which fluids from a well flow to the surface.

Flowing Pressure—The pressure at the wellhead of a flowing well.

Flowing Well—A well which produces without any means of artificial lift.

Fluid—A substance that flows. Both liquids and gases are fluids. In common oil field usage, however, the term fluid refers to liquids.

Fluid Injection—Injection of gases or liquids into a reservoir to force oil toward and into producing wells.

Flush Production—The high initial rate of flow from a good well.

Formation—A bed or deposit composed of substantially the same kinds of rock. Each different formation is given a name, frequently as a result of the study of the formation outcrop at the surface and sometimes based on fossils found in the formation.

Formation Damage—The reduction of permeability in a reservoir rock arising from the invasion of drilling fluid and treating fluids into the section adjacent to the wellbore. Often called skin dammage.

Formation Fracture Gradients—Pressure per unit depth at which the formation rocks will fail causing interconnecting cracks to form in the rock beds with resultant penetration of the formation by wellbore fluid.

Formation Pressure—The pressure exerted by formation fluids, recorded in the hole at the level of the formation, with the well shut in.

Formation Water—The water portion of the crude oil mixture that comes from the ground. Crude oil is generally made up of natural gas, petroleum, and formation water (also called produced water). Formation water is contaminated with hydrocarbons and possibly with heavy metals and hydrogen sulfide. The water must be separated from the crude oil before it is delivered to a refinery.

Fracturing—Application of hydraulic pressure to the reservoir formation to create fractures through which oil or gas may move to the wellbore.

Gas Cap—The upper portion of an oil-producing reservoir occupied by free gas.

Gas Hydrates—Icelike structures of gas and water in which gas molecules are trapped within a framework or cage of water molecules.

Gas Injection—Natural gas injected under high pressure into a producing reservoir through an input or injection well as part of an enhanced recovery operation.

Gas Lift—The raising, or lifting of liquid from a well by means of injecting gas into the liquid.

Gas-Liquid Ratio (GLR)—The number of cubic feet of gas produced with a barrel of liquid. (Usually water and oil.)

Gas-Oil Ratio (GOR)—The number of cubic feet of gas produced with a barrel of oil.

Gas Plant Products—Liquids recovered from natural gas in a gas processing plant and, in some situations, from field facilities. See "Natural Gas Liquids."

Gas Processing Plant (Gas Plant)—A facility designed (1) to achieve the recovery of natural gas liquids from the stream of natural gas which may or may not have been processed through lease separators and field facilities, and (2) to control the quality of the natural gas to be marketed.

Gas Regulator—A device for controlling the pressure of gas flowing in a pipeline.

Gas Well—A well capable of producing natural gas.

Gathering Lines—The flow lines which run from several wells to a central lease or plant facility.

Geologic Hazard—A feature or condition in the earth's geologic structure which may pose risks to oil exploration, development or production activities. Mitigation of the hazard's risk potential may necessitate special engineering considerations or relocation of a facility.

Geology—The scientific study of the origin, history and structure of the earth as recorded in rocks. A person trained in geology is a geologist. A petroleum geologist is primarily concerned with sedimentary rocks where most of the world's oil has been found.

Geophysics—The study of the earth's surface as revealed by differences in rock density and distribution; studied by means of seismic, magnetic, and gravity surveys. A person trained in geophysics is a geophysicist.

Gradient, Pressure—Pressure change with depth, expressed in psi/ft.

Gradient, Temperature—Temperature change with depth, expressed in ^{o}F /100 ft.

Gravity Drainage—The movement of the oil in the reservoir toward the wellbore due to the force of gravity.

Gravity-Specific—Density expressed as the ratio of the weight of a volume of substance to the weight of an equal volume of another standard substance. In the case of liquids and solids, the standard is fresh water. In the case of natural gas or other gaseous material, the standard is air.

Gunk—The collection of dirt, paraffin, oil, mill scale, rust, and other debris that is cleaned out of a pipeline when a scraper or a pig is put through the line.

Guyed Tower—A relatively slender trussed steel column of constant cross section which supports one or more decks. The tower is held in place by guylines extending radially from the top of the tower to clump weights and anchors on the ocean floor. The tower is a compliant structure, designed to move with environmental forces rather than resist them.

Hand—Practically anyone who works in the oil industry, but especially applied to those who work in the field.

Hang The Rods—To pull the rods out of the well and hang them in the derrick.

Hard Hat—Molded plastic hat worn in the field for protection.

Headache!—A warning cry given by a fellow worker when anything is accidentally dropped or falls from overhead toward another worker.

Heavy Metals—Certain potentially toxic metals such as barium (Ba), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), silver (Ag), and zinc (Zn).

Heavy Oil—Crude oil portions with heavier molecular weight; tend to be heavy, thick, and not flow easily; produces good asphalts.

High-Cost Gas—Gas that would cost more to produce than would normally be expected such as gas produced from below 15,000 feet or gas produced from certain designated tight formations.

Hold-Down—A mechanical arrangement to prevent the upward movement of certain pieces of equipment installed in a well.

Hole—The wellbore.

Holiday—A gap or void in the coating of a pipe or in paint on a metal surface.

Hot Oil—Oil production in violation of state regulations or transported interstate in violation of federal regulations.

Hot Oil Treatment (To Hot Oil)—A treatment using heated oil to melt and remove accumulated paraffin from the tubing, annulus, flow lines or production equipment.

Hot Tapping—Making repairs or modifications on a tank, pipeline, or other installation without shutting down operations.

Hydrate Zone—The formation or formations containing gas hydrates. See "Gas Hydrates."

Hydrocarbon—Any of a large class of organic compounds containing primarily carbon and hydrogen. Hydrocarbons include crude oil and natural gas.

Hydrocarbon Potential—See "Area of Hydrocarbon Potential."

Hydro-Test (Hydrostatic Testing)—To apply hydraulic pressure (usually with water) in order to find leaks in tubing, lines, vessels and equipment.

Initial Potential (IP)—The initial capacity of a well to produce.

Injected Gas—High pressure gas injected into a formation to maintain or restore reservoir pressure or otherwise enhance recovery. Also, gas injected for gas-lift.

Input Well—A well which is used for injecting fluids into an underground stratum.

Intermediate Casing String—The casing set in a well after the surface casing. Also called production casing.

Jacket—See "Steel-Jacketed Platform."

Jack-Up Unit—An offshore drilling structure with tubular or truss legs that support the deck and hull. When positioned over the drilling site, the leg bottoms rest on the seafloor. A jack-up unit is towed or propelled to a location with its legs up.

Joint—A length of pipe, casing or tubing, usually from 20 to 30 feet long.

Junk—Metal debris lost in a hole. Junk may be a lost bit, milled pieces of pipe, wrenches, or any relatively small object that must be fished out of the hole.

Kelly—A length of pipe or hollow forging with shoulders on the outside, either square or hexagonal, that fits into a matching shouldered hole in the rotary table and is screwed into the top of the drill pipe string.

Kick-Off—To bring a well into production.

Kill A Well—To stop a well from producing so that surface connections may be removed for well servicing or workover. It is usually accomplished by circulating water or mud to load the hole and render it incapable of flowing.

Lay Barge—A shallow-draft, barge-like vessel used in the construction and laying of underwater pipelines in swampy areas and to offshore platforms.

Lease—(1) A legal document that conveys to an operator the right to drill for oil and gas. (2) The tract of land, on which a lease has been obtained, where the producing wells and production equipment is located.

Lease Automatic Custody Transfer (LACT or ACT)—The measurement and transfer of oil from the producer's tanks to the oil purchaser's pipeline on an automatic basis without a representative of either having to be present.

Lease Operator—See "Operator."

Lease Sale—An MMS proceeding by which leases for certain OCS tracts are offered for sale by competitive sealed bidding and during which bids are received, announced, and recorded.

Lease Term—Duration of a lease. Oil and gas leases are issued for an initial period of 5 years or not to exceed 10 years where such longer period is necessary to encourage exploration and development in areas because of unusually deep water or other unusually adverse conditions. Once production is reached, the term continues as long as there is production.

Leasing Map—See "OCS Leasing Maps and Official Protraction Diagrams."

Leasing Phase—MMS's five-year lease sale process defines the leasing phase of OCS oil and gas development; the oil industry and federal and state governments prepare fro the Lease Sale, which marks the transition into the Exploration Phase.

Lessee—A person or persons to whom a lease is awarded; the recipient of a lease. See "Operator."

Lifting Costs—The costs of producing oil from a well or a lease.

Light Oil— Portions of crude oil of lighter molecular weight; tend to flow easily and make good gasolines.

Limestone—A type of sedimentary rock rich in calcium carbonate. Limestone sometimes serves as a reservoir rock for petroleum.

Liquefied Natural Gas (LNG)—Natural gas that is purified, then cooled and compressed until it froms a liquid.

Liquefied Petroleum Gas (LPG)—A compressed hydrocarbon gas obtained through distillation and usable as a fuel for certain processes.

Location—The place at which a well is to be or has been drilled.

Long String (Casing)—See "Production Casing".

Make Up—To assemble and join parts to form a complete unit, as to make up a string of tubing. To screw together two threaded pieces.

Manifold—An accessory system of valves and piping to a main piping system (or another conductor) that serves to divide a flow into several parts, to combine several flows into one, or to reroute a flow to any one of several possible destinations.

Marine Riser—See "Riser Pipe."

Microlayer—The thin (one milimeter) layer at the surface of seawater.

Minimum Royalty—The lowest payment a lessee must pay on a Federal or Indian lease after production begins. It is equivalent to the yearly rental, typically $3 per acre or $8 per hectare (offshore). Rentals are paid annually before a discovery; royalties are paid on production after a discovery. If the total royalty payments amount to less than the yearly rental, the minimum royalty payments make up the difference. See "Royalty."

Mitigation—Measures which if implemented would: 1) avoid impacts altogether by not taking actions or parts of actions (e.g. not approving portions of the project); 2) minimizing impacts by limiting the degree or magnitude of the action and its implementation; 3) rectifying the impact by repairing, rehabilitating, or restoring the impacted environment; 4) reducing the impact over time by preservation and maintenance operations during the life of the project; 5) compensating for the impact by replacing or providing substitute resources or environments.

Mobile Offshore Drilling Unit—A drilling vessel that floats upon the surface of the water when being moved from one location to another. It may or may not float once drilling begins. Mobile units include jack-up drilling units, semisubmersibles, submersibles, and drillships.

Mud—The liquid circulated through the wellbore during rotary drilling and workover operations. In addition to its function of bringing cuttings to the surface, drilling mud cools and lubricates the bit and drill stem, protects against blowouts by holding back subsurface pressures, and deposits a mud cake on the wall of the borehole to prevent loss of fluids to the formation.

Multiple Completion—A well equipped to produce oil and/or gas separately from more than one reservoir.

NPDES—National Pollution Discharge Elimination System. A permit required by the Environmental Protection Agency for discharges into ocean waters.

Natural Gas—A mixture of hydrocarbons and varying quantities of nonhydrocarbons that exists either in the gaseous phase or in solution with crude oil in natural underground reservoirs.

Natural Gas Liquids (NGL)—Hydrocarbons that occur naturally in gaseous form or in solution with oil in a reservoir, and that are recoverable as liquids by condensation or absorption .

Nautical Mile—A measure of marine distance equal to 6,076 feet or 1,852 meters.

Neuston—The upper several centimeters of the ocean surface.

Net Profit Share—A bidding system for leasing tracts on the OCS that uses the cash bonus as the bid variable and requires a fixed annual rental payment and net profit share payments at a fixed percentage rate that is constant for the duration of the lease.

Nominations—The amount of oil or gas a purchaser expects to take form a field as reported to a state regulatory agency.

Non-Associated Gas—Natural gas which is in reservoirs that do not contain significant quantities of crude oil.

Nonenergy Minerals—All minerals other than oil, gas, and sulphur.

Non-Operator—A working-interest owner other than the one designated as operator of the property.

Notices to Lessees and Operators—The MMS documents used to distribute information and Operators to lessees and operators. The NTL's may be issued for several reasons, e.g., providing an interpretation of a regulation or transmitting administrative information such as a change in an MMS office address.

OCS—See "Outer Continental Shelf."

OCS Leasing Maps and Official Protraction Diagrams—Basic geographical records; maps used in lease sales. Leasing maps are used in the Gulf of Mexico (nearshore Texas and Louisiana) and in small areas offshore California. Leasing maps are developed on the basis of extensions of the leasing grids used onshore. Most of the offshore area is mapped on official protraction diagrams (OPDs) using the Universal Transverse Mercator grid system. Each OPD covers 1 degree latitude by 2 degrees longitude (except for offshore Alaska which is 1 degree latitude by 3 degrees longitude) and is divided into blocks.

Each leasing map or OPD bears a distinct alphanumeric number and in most cases a name based on onshore land features, a nearby city or town, or the hydrographic features contained within the limits of the diagram. Shoreline detail is also depicted on the OPD when it falls within the limits of the particular diagram.

Off Production—Said of a well when it is shut in or temporarily not able to produce.

Offshore—That geographic area which lies seaward of the coastline.

Offshore Storage and Treating Vessel (OS&T)—A converted vessel, usually a tanker anchored by a platform, used to remove natural gas, water and other impurities from crude oil and to store the treated product until it is offloaded for transport to a refinery by a shuttle tanker.

Oil—A fluid composed of hydrocarbons (for purposes of this report).

Oil and Gas Separator—An item of production equipment used to separate the liquid components of the well stream from the gaseous components.

Oil Operator (Operator)—An individual or company engaged in the business of finding and producing oil and gas.

Oil Spill Contigency Plan—A plan submitted by the oil/gas lessee to the MSS, with an EP and DPP, that details provisions for the fully defined, specific actions to be taken following discovery of an oil spill. This includes both the procedure for notification and clean-up response to the spill, as well as a listing of the clean-up equipment and materials that will be available.

Oil Well—A well completed for the production of crude oil from at least one oil zone or reservoir.

On The Pump—A well that is not capable of flowing and is produced by means of a pump.

Open Hole—Uncased portion of a well.

Operator—The individual, partnership, firm, or corporation having control or management of operations on a leased area or a portion thereof. The operator may be a lessee, designated agent of the lessee, or holder of rights under an approved operating agreement.

OS&T—See "Offshore Storage and Treatment Vessel."

Outer Continental Shelf (OCS)—The part of the continental shelf beyond the line that marks State ownership; that part of the offshore lands under Federal jurisdiction.

Overproduced—Said of a well that has produced more than is allowable.

Packer—An expandable plug-like device for sealing off the annular space between the well's tubing and the casing.

Paraffin—Heavier paraffin-base hydrocarbons often form a waxlike substance called paraffin. Paraffin may accumulate on the walls of tubing, flow lines and other production equipment, thus restricting the flow of well fluids to the extent that it must be removed. See "Hot Oil Treatment."

Pay Out—The recovery from production of the costs of drilling, completing, and equipping a well.

Pay Sand—The producing formation, or that formation which represents the objective of drilling. Also referred to as "pay."

Permafrost—Permanently frozen subsoil in arctic or subarctic regions.

Permeability—The measure of a rock's ability to transmit fluids; a measure of the ease with which fluids can flow through a porous rock.

Permeability (of a reservoir rock)—The ability of a rock to transmit fluid through the pore spaces—a key influence on the rate of flow, movement and drainage of the fluid. There is no necessary relation between porosity and permeability. A rock may be highly porous and yet impermeable if there is no communication between pores. A highly porous sand is usually highly permeable.

Permit—An authorization to do some activity, granted by a governmental regulatory agency.

Petrochemical Plants—Plants than turn crude oil fractions or their processed derivatives into feedstocks that are used in the manufacture of many other products, from liquid detergents to plastics.

Petrochemicals—A chemical substance that is commercially produced from crude oil, natural gas, or their derivatives.

Petroleum—Oil or gas obtained from the rocks of the earth by drilling down into a reservoir rock and piping them to the surface; most often a complex mixture of hydrocarbons of different types, with small amounts of other substances.

Petroleum Rock—Sandstone, limestone, dolomite, fractured shale, and other porous rock formations where accumulations of oil and gas may be found.

Pig—A device inserted in a pipeline for the purpose of sweeping the line clean of water, rust, or other foreign matter. Also known as "Go-Devil".

Pig A Line—To run or put a pig or scraper through a pipeline.

Pig Iron—Any piece of oilfield equipment made of iron or steel.

Pipeline Gas—Gas which meets gas pipeline purchaser specifications.

Pipeline Oil—Clean oil. Crude oil whose BS&W content is low enough to make the oil acceptable for transport or pipeline shipment.

Plan of Development and Production—See "Development and Production Plan."

Plan of Exploration—See "Exploration Plan."

Planning Area—A subdivision of an offshore area used as the initial basis for considering blocks to be offered for lease in the DOI's areawide offshore oil and gas leasing program.

Platform—An offshore structure from which offshore wells are drilled, produced, or both. See "Compliant Platform" and "Steel-Jacketed Platform."

Platform Jacket—See "Steel-Jacketed Platform."

Play—A group of prospective reservoirs or oil fields that are geologically similar, exhibiting the same source, reservoir, or trap characteristics and controls.

Plug and Abandon—Expressions, often abbreviated "P&A", referring to the act of placing plugs in a depleted well or dry hole, then abandoning it. See "Abandon."

Porosity (of a reservoir rock)—The percentage that the volume of the pore space bears to the total bulk volume. The pore space determines the amount of space available for storage of fluids.

Porosity—The ratio of the holes, voids, or pores in a rock to its total volume or size.

Pressure Gage—An instrument for measuring fluid pressure.

Pressure Maintenance—Maintaining reservoir pressure by injecting fluid, normally water or gas, or both.

Pressure Regulator—A device for maintaining pressure in a line, downstream from the device.

Pressure-Relief Valve—A valve that opens at a preset pressure to relieve excessive pressures within a vessel or line; also called a relief valve, safety valve, or pop valve.

Primary Recover—The natural flow from a production well; the first phase of production from a well.

Produced Water—See "Formation Water."

Producing Platform—An offshore structure accommodating a number of producing wells. Also see "Well Platform."

Production Casing (Production String)—The last string of casing set in a well; the casing string set to the top or through the production formation and inside of which is usually suspended the tubing string. Also called the oil string or long string.

Production Phase—The yield of an oil or gas well. Also that branch of the petroleum industry that has to do with bringing the well fluids to the surface and separating them, and with storing, gaging, and otherwise preparing the product for the pipeline; the phase of oil and gas operations involved with well fluids extraction, separation, treatment, storage, measurement, and (sometimes) transportation.

Production Platform (Processing Platform)—An offshore structure providing a central processing and disposition point for fluids produced from wells on adjacent producing and well platforms. The treated oil and gas is moved to shore through submarine pipelines. Produced water is generally disposed of within the field.

Proprietary Information—Geologic and geophysical data, information, and derivatives thereof that cannot be released to the public for a specified term because of Federal law, regulations, or statutes, or because of contractual requirements.

Proration— A system of allocating the amount of oil or gas a well or field is allowed to produce within a given period by a regulatory agency.

PSI—Pounds per square inch.

Pull A Well—To remove rods or tubing from a well.

Pump—A device used to increase the pressure of or move liquids. Types of pumps include: sucker rod, reciprocating, centrifugal, rotary, gear, and jet.

Put A Well On—To start a well flowing or pumping.

Qualified Bidder—A bidding entity or person who has met the appropriate requirements of 30 CFR Part 256, Subpart G, and of the notice of sale.

Rack Pipe—To stand pipe in the derrick when coming out of the hole or to stack pipe on a pipe rack.

Recoverable Resource Estimate—An assessment of the oil and gas resources that takes into account the fact that physical and technical constraints dictate that only a portion of resources or reserves can be brought to the surface.

Recompletion Operations—To perform operations to change producing formations in an existing well.

Refinery—A large plant that processes crude oil into many components. The plant receives crude oil (which has normally been separated and treated) and uses processes that include heating, fractionating, pressure, vacuum, reheating in the presence of catalysts, and washing with acids. The resulting components will range from gasoline, kerosene, lubricating oils, bunker fuel light gases to petroleum coke.

Refining—Fractional distillation, usually followed by other processing (as cracking).

Relief Well—A well that is drilled and deviated so that it bottoms out near the borehole of a blown-out well. Then mud is pumped down the relief well to kill the wild well.

Remote Control Station—A centrally located station containing equipment to control and regulate operations in one or more fields.

Reserve Estimate—An assessment of the portion of the identified oil and gas resource that can be economically recovered.

Reserves—A discovered resource. That portion (in barrels or cubic feet) of an identified oil or gas resource which can be economically extracted using current technology. See "Economically Recoverable Resource Estimate" and "Resources and Reserves (DOI)."

Reservoir— A subsurface porous and permeable rock body that contains oil and/or gas.

Reservoir Pressure—The pressure at the face of the producing formation when the well is shut in.

Resources—Concentrations of naturally occurring solid, liquid, or gaseous materials in or on the Earth's crust. These include both identified (discovered) and undiscovered resources. See "Undiscovered Recoverable Resources" and "Resources and Reserves (DOI)."

Resources and Reserves (DOI)—DOI has four major classifications of offshore oil and gas potential:

(1) *Undiscovered economically recoverable resources*—Resources outside of known fields estimated to exist in potential commercial accumulations. The presence of these resources is postulated on the basis of geologic, engineering, and economic inferences.
(2) *Measured reserves*—Proved reserves in known fields. They are reserves that are part of the economically identified resource that is estimated from geologic evidence supported directly by engineering measurements.
(3) *Indicated reserves*—The additional quantities of crude oil and gas in known reservoirs (in excess of the measured reserves) which are believed to be economically recoverable by application of enhanced recovery techniques, whether or not such a program is currently installed.
(4) *Inferred reserves*—Quantities of oil and gas in known oil and gas fields that may be found by further drilling through producing layers and discovery of new pay zones.

Reworking A Well (Remedial Operations)—To restore production from an existing formation when it has fallen off substantially or ceased altogether.

Rig—The derrick, drawworks and attendant surface equipment of a drilling or workover unit.

Right Of Use And Easement—For the OCS, a right of use and easement usually refers to the authorization by MMS to a lessee for the construction and maintenance of a pipeline or other structure on OCS lands not subject to the lessee's lease.

Right-Of-Way—For the OCS, a right-of-way usually refers to the authorization by MMS for the construction and maintenance of a pipeline and associated structures on the OCS.

Riser—A pipe through which liquid travels upward.

Riser pipe—The pipe and special fittings used on floating offshore drilling rigs to establish a seal between the top of the wellbore, which is on the ocean floor, and the drilling equipment located above the surface of the water. A riser pipe serves as a guide for the drill stem from the drilling vessel to the wellhead and as a conductor of drilling fluid from the well to the vessel. The riser consists of several sections of pipe and includes special devices to compensate for any movement of the drilling rig caused by waves. Further, pipelines for transporting hydrocarbons necessarily have "riser pipes" connecting the pipeline from the sea floor to the platform production deck. A riser pipe is also called a marine riser.

Riser System—See "Riser Pipe."

Roughneck—Any laborer working on an oil-drilling rig.

Round-Trip—To pull out and subsequently run back into the hole a string of drill pipe, tubing or sucker rods. Also termed "trip."

Roustabout—Any unskilled laborer, as in an oil field.

Royalty—A share of the minerals produced from a lease; a percentage of production either in money or in kind which a lessee of a Federal or Indian lease is required to pay. See "Royalty-in-Kind."

Royalty-In-Kind—A payment by a lessee in crude oil rather than in cash for the amount of royalty due in the Federal Government as the Federal Government's share (per the lease contract) of the extracted oil and gas. (The Federal Govemment then sells the crude oil to eligible refiners who in turn pay for the value of the oil in the form of a monetary payment.)

Royalty Interest—The fraction of the oil and gas retained by the mineral rights owner under the lease agreement.

Run—The amount of crude oil sold and transferred to the pipeline by the producer.

Run In—To go into the hole with tubing, drill pipe, etc.

Run Ticket—A record of oil transferred from the producer's storage tank to the pipeline. This is the basic legal instrument by which the lease operator is paid for oil produced and sold.

Sale Area—The grouping of whole and partial blocks within a specific planning area offered for sale.

Sand—A loose material most commonly composed of small quartz grains formed from the disintegration of preexisting rocks. Also see "Sandstone."

Sandstone—A compacted sedimentary rock composed of the minerals quartz or feldspar. Sandstone is a common rock in which petroleum and water accumulate.

Scoping—A "reaching-out" process intended to involve all interested persons and groups (Federal and non-Federal) in determining issues, areas, and alternatives to be studied in the EIS.

Scrubber—A vessel through which gas is passed to remove liquid and foreign matter.

Secondary Recovery—Methods used to enhance well production after primary recovery no longer produces sufficient commodity. This frequently involves injecting water or gas into the reservoir rock.

Secondary Treatment—Techniques to increase production from a well once the resource is somewhat depleted and primary techniques no longer produce an adequate flow.

Sedimentary Rock—A rock composed of materials that were transported to their present position by wind or water. Sandstone, shale, and limestone are sedimentary rocks.

Seep—A naturally occurring leakage of petroleum from natural sources.

Seismic—Pertaining to characteristics, or produced by, earthquakes or earth vibration; having to do with elastic waves in the earth.

Seismic Survey—A method of geophysical prospecting using the generation, reflection, refraction, detection, and analysis of elastic waves in the earth.

Semisubmersible—A floating offshore drilling structure that has hulls submerged in the water but not resting on the seafloor.

Separator—A pressure vessel used for the purpose of separating gas from crude oil and water.

Separation and Treatment Plant—A facility that separates gases and water from crude oil. The process uses a series of treatment facilities and holding tanks and processes the crude oil with a variety of gravity, heat, chemical, and electric treatments. If necessary, the treatment will include sweetening sour gas.

Service Well—A non-producing well used for injecting liquid or gas into the reservoir for enhanced recovery. Also a sale-water disposal well or a water supply well.

Shale—A fine-grained sedimentary rock composed of silt and clay sized particles. The most frequently occurring sedimentary rock.

Show—Evidence of gas or oil found by examining rock cuttings and drilling muds while drilling an exploratory well.

Shut In—To close valves on a well so that it stops producing; said of a well on which the valves are closed.

Shutdown Phase—The final phase of oil and gas production, when industry stops production because it's no longer profitable, generally 20 or more years after production begins. Typically, offshore facilities are removed, well pipes are cut off below the mudline, and onshore facilities may be dismantled or converted.

Significant Impact—A substantial, or potentially substantial, adverse change in the environment resulting from a project.

Single-Point Mooring—Offshore anchoring and loading or unloading point connected to shore by an undersea pipeline; used in areas where existing harbors are not deep enough for laden tankers. It is also used in connection with subsea production.

Skimmers—Boats or devices that siphon or skim spilled oil off the top of water.

Smart Pig—A computerized pig, used to inspect pipelines.

Solution Gas—Natural gas dissolved in crude oil and held under pressure in the oil in a reservoir.

Sorbents—Materials that attract and absorb oil; useful in oil cleanup.

Sour Crude Oil (Sour Crude)—An oil containing free sulphur or other sulphur compounds whose total sulphur content is in excess of one percent. Usually called high sulfur crude.

Sour Gas—Natural gas containing hydrogen sulfide.

Spacing—Distance between wells producing from the same reservoir (usually expressed in terms of acres, e.g., 10-acre spacing).

Spud—To begin drilling a well.

Stabilized—A well is considered "stabilized" when, in the case of a flowing well, the rate of production through a given size of choke remains constant, or, in the case of a pumping well, when the fluid column within the well remains constant in height.

Steel-Jacketed Platform—A platform of one or more decks on which drilling and production equipment is mounted and which is supported by a conventional steel tower. The tower (or "jacket") consists of welded steel tubular members; like a stool, it increases in horizontal cross section from top to bottom. The jacket is connected to the ocean floor by pilings driven through the legs and grouted with cement in the space between the pile and the jacket. The platform is then fitted into the jacket and secured. This type of platform is designed to resist environmental forces.

Stimulation—The descriptive term used for several processes to enlarge old channels, or create new ones, in the producing formation of a well, i.e., acidizing or fracturing.

Stipulations—Specific measures imposed upon a lessee that apply to a lease. Stipulations are attached as a provision of a lease; they may apply to some or all tracts in a sale. For example, a stipulation might limit drilling to a certain time period of the year.

Strategic and Critical Minerals—Minerals that (1) would be needed to supply the military, industrial, and essential civilian needs of the United States during a national defense emergency, and (2) are not found or produced in the United States in sufficient quantities to meet such needs.

Stratum—A thin sheet of sedimentary rock formed by natural causes, usually a series of layers lying between beds of other kinds.

String—Refers to the casing, tubing, or drill pipe in its entirety, i.e., the casing string, etc.

Structure—An underground geological feature capable of forming a reservoir for oil and gas.

Subsurface Safety Valve—A safety device installed in the well's tubing below the surface to automatically shut the well in when predetermined flow rate, pressure, or other conditions are used.

Summary Report—A document prepared by the Interior Department for affected state and local governments as to current OCS reserve estimates, projections of magnitude and timing of development, transportation planning, and general location and nature of nearshore and offshore facilities.

Sundry Notice—A form used by a lessee for requesting approval from MMS for specific work on a well such as cleaning out sand or treating with acid to increase production.

Supply Vessel—A boat that ferries food, water and supplies and equipment to a rig and returns to land with refuse that cannot be disposed of at sea.

Supply Base—A port area developed to support development and production platforms; includes berthing for supply and work boats, warehouse space, maintenance facilities, staging yards, etc.

Surface Casing—The first string of casing to be set in a well. Its principal purpose is to protect fresh water sands.

Surge Tank—A vessel on a flow line whose function is to receive and cushion sudden rises or surges in the stream of liquid.

Suspension of Operations or Production—An authorized temporary cessation or prohibition of Production activities on a leasehold. As of the effective date of a suspension, time on a lease stops for the life of the suspension, thus having the effect of extending the term of a lease for a period of time equal to the length of time of the suspension.

Sweet—Said of oil or gas when it contains no sour impurities.

Tattletale— A device on an instrument control panel to indicate the cause of a system shutdown or alarm signal.

Tender—A barge or small ship serving as a supply and storage facility for an offshore drilling unit; a supply ship.

Tension Leg Platform—A floating platform of the compliant type which is used for drilling or production and is restrained and located by tension cables or articulated supports from the ocean bottom.

Tertiary Recovery—Methods used to enhance well production after secondary recovery no longer produces sufficient commodity.

Term—See "Lease Term."

Thief—A metal cylinder with a spring actuated closing device that is lowered into a tank to obtain samples of oil at any given depth.

Ton—Short ton = 2,000 pounds; long ton = 2,240 pounds.

Tract—A designation assigned for administrative and statutory purposes to a block or combination of blocks that are identified on a leasing map or an official protraction diagram prepared by MMS. A tract may not exceed 5,760 acres unless it is determined that a larger area is necessary to comprise a reasonable economic production unit. See "Leasing Map," "Block," and "Bidding Unit."

Trans-Alaska Pipeline (TAP)—A 48-inch-diameter pipeline, 800 miles long, completed in 1977, that transports crude oil from the Alaskan North Slope to the ice free port of Valdez.

Trap (Geologic)—An arrangement of rock strata or structures that halts the migration of oil and gas and causes them to accumulate.

Trip—See "Round-Trip."

Trunk Lines—A main line; a large-diameter pipeline between distant points.

Tubing—A string of relatively small diameter pipe that may be run in the well inside the cemented well casing. Hydrocarbons pass through the tubing to the wellhead. Using tubing facilitates repairs, since tubing can be removed, while casing is cemented in place.

Underwater Manifold—See "Manifold."

Undiscovered Economically Recoverable Resources—Quantities of economically recoverable oil and gas that are estimated to exist outside known fields.

Undiscovered In-place Resources—Quantities of oil and gas that are estimated to exist outside known fields, without reference to technological or economic factors.

Unit—Administrative consolidation of OCS leases held by two or more companies but explored, developed, and/or produced by one operator for the purposes of conservation, eliminating duplication of operations, and/or maximizing resources recovered.

Unitization—Unitization is the process whereby the owners of adjoining properties pool their reserves and form a single unit for the operation of the properties by only one of the owners. The production from the unit is then divided on the basis established in the unit agreement. The purpose of such agreement is to produce the reserves more efficiently, increasing the recovery for every participant. This is especially important where enhanced recovery is anticipated.

Unit Operator—The company designated to operate unitized properties.

Vapor Recovery Unit—A facility for collecting stock or storage tank vapors to prevent their loss to the atmosphere.

Vent—A connection in a vessel, line, or pump to permit the escape of air or gas.

Viscosity—A measure of how easily a liquid will pour or flow.

Volatile—Capable of being readily vaporized, rapidly evaporating.

Water-Coning—The upward encroachment of water into a well due to pressure drawdown from production.

Water Flooding—One method of enhanced recovery in which water is injected into an oil reservoir to force additional oil out of the reservoir rock and into the well bores of producing wells.

Water Well—A well drilled to (1) obtain a fresh water supply to support drilling and production operations, or (2) obtain a water supply to be used in connection with an enhanced recovery program.

Weathered Crude—Crude oil which has lost an appreciable quantity of its entrained gas due to evaporation during storage.

Well—A hole drilled in the earth for the purpose of finding or producing crude oil or natural gas. See "Service Well."

Well Completion—The activities following the drilling phase to place a well in a production status.

Well Permit—The authorization to drill a well issued by a governmental regulatory agency.

Well Platform—An offshore structure with a platform above the surface of the water that supports the producing well's surface controls and flow piping.

Well Servicing—The maintenance work performed on an oil or gas well to improve or maintain the production from a formation already producing in the well. Usually, it involves repairs to the pump, rods, gas-lift valves, tubing, packers, etc.

Well Workover—See "Workover."

Wellhead—The equipment used to maintain surface control of a well.

Wet Gas—Natural gas containing significant amounts of liquefiable hydrocarbons.

Wild Well—A well that has blown out, caught on fire, and cratered.

Wildcat Well—An oil or gas well drilled in previously unexplored areas. Also, "rank wildcat."

Work Boat—A boat or self-propelled barge used to carry supplies, tools, and equipment to job site offshore.

Working Interest—The operating interest under an oil and gas lease.

Workover—Operations on a producing well to restore or increase production. A workover may be done to wash out sand, acidize, hydraulically fracture, mechanically repair or for other reasons. See "Reworking a Well."

Zone—The term "zone," as applied to reservoirs, is used to describe a unique interval which has one or more distinguishing characteristics, such as lithology, porosity, saturation, etc.