Coastal Zone
Information
Center

COASTAL ZONE
INFORMATION CENTER

# THE OIL SPILL PROBLEM

FIRST REPORT
OF THE
PRESIDENT'S PANEL ON OIL SPILLS

U.S. EXECUTIVE OFFICE OF THE PRESIDENT,
Office of Science and Technology.

GC
1080
.U52
1969

## Contents


| | Page |
|---|---|
| List of Panel Members | i |
| Summary of Findings and Recommendations | iii |
| The Oil Spill Problem | 1 |
| Introduction | 1 |
| Oil Spills | 3 |
| Combatting a Large Oil Spill | 6 |
| Anatomy of a Program | 6 |
| Oil Spill Surveillance | 6 |
| Techniques | 6 |
| Prediction | 7 |
| Sampling and Identification | 7 |
| Containment, Removal and Disposal | 8 |
| Containment | 8 |
| Recovery | 9 |
| Open Sea Removal | 9 |
| Cleanup | 10 |
| Oil and Environmental Effects | 11 |
| Restoration | 11 |
| Information | 12 |
| Dispersants | 12 |
| Toxicity of Oil | 13 |
| Assessment of Biotic Effects | 14 |
| Ecological Research | 14 |
| Organization Requirements | 15 |
| Federal | 15 |
| Regional and State | 16 |
| International | 17 |
| Industry | 17 |
| Need for a National Overview | 17 |
| Avoiding Oil Spills | 19 |
| Transport by Tanker - Prevention of Oil Spills | 19 |
| Offshore Oil Development and Environmental Hazards | 21 |
| Bibliography | 24 |
| Acknowledgments | 25 |



Property of CSC Library

U.S. DEPARTMENT OF COMMERCE NOAA
COASTAL SERVICES CENTER
2234 SOUTH HOBSON AVENUE
CHARLESTON, SC 29405-2413

Property of CSC Library

AUG 2 0 1997

GC1080.U52 1969
#101309

# SANTA BARBARA OIL SPILL PANEL

Chairman:
Dr. John C. Calhoun, Jr.
Vice President,
Texas A&M University
College Station, Texas

Dr. Norman H. Brooks
Professor of Civil Engineering
California Institute of Technology
Pasadena, California

Dr. John P. Craven
Chief Scientist, Special Projects Office
Navy Department
Washington, D. C.

Dr. William Drury
Director of Research
Massachusetts Audubon Society
South Lincoln, Massachusetts

Mr. Morris Ettinger
Dow Chemical Company
Midland, Michigan

Dr. Galen E. Jones
Professor of Microbiology and
Director, Jackson Estuarine Laboratory
University of New Hampshire
Durham, New Hampshire

Dr. Gordon J. F. MacDonald
Vice Chancellor for Research and Graduate Affairs
University of California Santa Barbara
Santa Barbara, California

Dr. Jack E. McKee
Professor of Environmental Health Engineering
California Institute of Technology
Pasadena, California

Dr. Henry W. Menard
Institute of Marine Resources
Scripps Institution of Oceanography
La Jolla, California

Dr. William Nierenberg
Director
Scripps Institution of Oceanography
La Jolla, California

Dr. Carl H. Oppenheimer
Director
Oceanographic Institute
Florida State University
Tallahassee, Florida

Dr. Luigi Provasoli
Haskins Laboratories
New York, N. Y.

Mr. Carl H. Savit
Vice President, Research and Development
Western Geophysical Company of America
Houston, Texas

Dr. William Walton
Geological Research Director
Pan American Petroleum Corporation
Tulsa, Oklahoma

Staff:

Dr. John S. Steinhart - Office of Science and Technology
Mr. Howard H. Eckles - Office of Science and Technology
Dr. David A. Adams - Marine Science Council Staff

Advisers:

Mr. Kenneth Biglane - Federal Water Pollution Control Administration
Dr. Quentin Bone - Plymouth Laboratories, Plymouth, England
Daniel B. Charter, Jr. Commander - U.S. Coast Guard
William E. Lehr, Commander - U.S. Coast Guard
Mr. Ross McClintock - Fluor Corporation
Dr. William T. Pecora - Director, U.S. Geological Survey
Mr. Leo McReynolds - National Petroleum Council

## SUMMARY OF FINDINGS AND RECOMMENDATIONS

1. Although oil spills cannot be eliminated entirely, steps can be taken to reduce the probability that they will occur. Steps can also be taken to prepare for oil spills so that the damage and deleterious effects are reduced. Despite the lessons learned from the Torrey Canyon, Santa Barbara and other spills, the nation is not doing enough in either of these areas. (Page 4)

2. The United States does not have at this time sufficient technical or operational capability to cope satisfactorily with a large scale oil spill in the marine environment. A research, development and deployment program to monitor and control massive spills should be implemented to advise the public of the probability and predictability of oil spills and of the existence and effectiveness of standby cleanup capabilities. (Page 6)

3. Responsibility for developing technology on oil spills should be vested in a single federal authority, with mandates to stimulate private industry involvement and to work coordinately with local governments. The authority responsible for developing an oil spill technology should also undertake the jobs of forecasting the probable incidences of oil spill events and arranging for deployment of emergency equipment accordingly. (Page 15)

4. Similarly, there is need to assign to a single agency the operational responsibility for dealing with an oil spill. The current contingency plan should be revised and implemented and it should provide for a fund upon which the commander of an oil spill team can draw for meeting the costs of operations to control an oil spill. (Page 15)

5. In all oil spill events, the contingency plan should also provide for assembling, separate from the operations team to combat the spill, a group of ecologists, environmental scientists, engineers, economists, and others with expertise in the area concerned, to advise the operations team and to recommend actions for appropriate studies and analyses to assess the effects of the spill. (Page 14)

6. There is no clear policy for determining when the public interest in an oil spill should preempt private interests. Jurisdictional responsibilities and liability for damage are not clearly defined. A review of legislative and administrative practices in these areas is recommended. (Page 16)

7. There is need for a quasi-independent advisory group on oil pollution to provide an overview of this subject for the benefit of the President, the Congress, and the public at large. We recommend that an Advisory Board on Oil Pollution and Hazardous Fluids be established to advise the President and the National Interagency Committee with respect to policies, programs, and plans relative to the prevention or mitigation of pollution from the transportation, processing and utilization of oily substances and other hazardous fluids. (Page 17)

8. Coastal areas of potentially high environmental risks relative to oil tanker shipping lanes and terminals should be identified. Steps should be taken immediately to negotiate international agreements providing firm regulatory control of shipping lanes used for transportation of oil and hazardous materials. (Page 20)

9. Within the federal agencies an authority and responsibility should be clearly identified and delegated for: (Page 20)

(a) Design specification and inspections of ships, barges and port facilities with respect to overall size, compartments, loading equipment, navigational equipment and ship control, and pollution control equipment.

(b) Monitoring and regulating ship movement in the territorial waters of the United States.

(c) Design specification, construction and inspection of pipelines carrying oil and hazardous fluids.

(d) Monitoring major spillage incidents with chronological estimates of oil contamination, and informing the operational agency responsible for cleanup.

10. Along many coastal regions the production of oil and gas is one of the most valuable industrial activities for direct economic return. Nevertheless in certain areas of great population density and high recreation and aesthetic value it is essential that: oil well operations

be conducted under stringent regulations and supervision using the most up-to-date technology in order to minimize the possibility of oil leakage; and any oil companies holding offshore leases be required to show their capability for control, containment and removal of spilled oil from the sea to the responsible agencies. (Page 21)

11. Because of variable oceanographic characteristics and differing beneficial uses of the ocean, the potential consequences or environmental degradation in case of well leakage are highly variable. Therefore, some situations require higher standards of operation and supervision than others. If special problems are encountered then special regulations and procedures may be required. (Page 22)

# THE OIL SPILL PROBLEM

"In utilizing and conserving the natural resources of the Nation, the one characteristic more essential than any other is foresight. Unfortunately. foresight is not usually characteristic of a young and vigorous people, and it is obviously not a marked characteristic of us in the United States."

Theodore Roosevelt

## Introduction

A new technology can seldom be developed in modern times unless someone is given specific responsibility and is funded at a level commensurate with doing the job. This question arises in particular with respect to the absence of a technology for handling oil spills. Although the nation has been alerted by such incidences as the Torrey Canyon wreck, and although a contingency plan has been formulated, the nation still does not have an adequate oil spill technology and has not yet provided the means for bringing an adequate technology into being.

In the history of civilization the development of new technology amply demonstrates that contributions are required both from the public and private sector. An individual can support his own patent development and can found a new company, but this is far from creating all the components that enter into the emergence of a technological system. The principal contribution which the public sector can provide is an atmosphere of interest in, acceptance for, and belief in the worthwhileness of developing the technology. Although such a public posture is necessary, it is not sufficient. Needed also, is a clear identification of responsibility for a public agency to do those things that are needed to see that the technology is developed even though actual implementation may be placed in private hands.

Adequate public funds must be provided, and these funds must be commensurate with the job that is to be done. Placing a man on the moon is a job which could not have been funded in the tens of millions of dollars. Although the development of a technology for handling oil spills in the open ocean is not the same order of magnitude as developing a technology to place a man on the moon or to build a nuclear energy system, the principle is the same.

An additional principle concerns the timing and the means of preparing to combat the undesirable effects which will accompany the development of any technology or resource. It is time that our Nation anticipated that undesirable effects will sooner or later arise from all segments of progress. We have generally ignored or underestimated the possible attendant hazards except in those instances where the hazard to human life was high.

It is to be expected that the increased use of the shoreline and the offshore zone will produce undesirable effects which will give rise to argument, damage to property or life, and to encroachment on environmental quality. The use of our marine resources has advanced, without equivalent attention being given to areas of possible conflict or to planning for the interactions that might occur. In short, we have followed our usual practice of deferring these considerations until we are in trouble. In particular, the development of offshore oil leases has been looked upon only as a resource production activity. There have been no serious questions raised about counter effects which might have been set in motion by this development.

It has been taken for granted, as a general public view, that all new resource and technological developments will be for the good. If we raise any question at all, it is that we expect those in charge of operations to take care of undesirable aspects associated with development.

In the case of offshore oil environment, it is necessary to look at the technological developments that are taking place, to inventory the present situation, to assess the probability of undesirable changes, and to lay out courses of action to keep environmental quality at the highest possible level.

The development of the offshore drilling industry over the past 20 years has proceeded in an orderly and "as the technology develops" basis. This development has taken place under both state and federal regulatory agencies on both state and federal offshore leases. The development of these resources has been profitable not only to the state and federal governments but has proved up considerable quantities of oil and gas reserves for the future needs of our country. The standards set for the construction and emplacement of the facilities to develop these reserves generally have proven to be adequate. Statistics show

that the incidence of accident and pollution from offshore drilling has been amazingly small. Most of the standards and controls for the development of offshore resources have been adequate. The pace of offshore exploration has indicated, however, that standards and controls should be reviewed by everyone involved before additional offshore exploration proceeds. It is obvious that the federal, state and local governments and the industries must work more closely in the development of our offshore resources and in the preservation of our coastal environments. Also, it should be incumbent upon everyone involved to better inform the public as to the desirability and/or necessity of developing offshore resources in an orderly, safe, and technologically feasible manner.

Oil Spills

Oil spills are usually accidents. As with all accidents, they are caused by human error and/or the use of a faulty technological system. Because human error is involved, the number of accidents is somewhat proportional to numbers of people involved in oil handling and to the increasing complexity of the systems involved. The number of accidents is dependent on the philosophy and outlook of the public and on the practices which it is willing to accept.

Accidents, and in particular oil spills, also result from poor or improper practices in the design of equipment, the state of technological advance, or the design of operations for handling oil. To the degree that such systems are improperly engineered or are not designed for safety, accidents will be more probable.

The method for handling oil spills depends largely on the fact that oil and water do not readily mix. Although there are a few other situations in which this non-mixing characteristic contributes to the handling of accidents, they are not very common. Therefore, it can be considered that the technology for handling oil spills is not similar to other, larger technological activities except that it may be related to other operations carried on within the marine evnrionment.

Thus oil spills should be approached as rather unique problems as far as technological requirements are concerned, but they may be considered from a broader sense with respect to generalities of accidents, organizational details for handling accidents, and philosophical views of the public.

There are two general questions to be addressed. The first is how to keep the number of accidents to a minimum. This requires prediction and prevention. The second is how to take care of accidents which happen despite our best preventive efforts. As a part of these two general questions, it is necessary to consider the state of knowledge about oil spill events and about the operations from which they evolve. Although precautionary measures, continued education of workers, improved organizational procedures, and advances in technology will reduce the number of accidents, oil spills cannot be eliminated entirely.

The spills that are of great concern now are those of extremely large volume. Large is, of course, a relative term. The Torrey Canyon spill was about 30 million gallons; the Ocean Eagle spill was about 3 million gallons; the Santa Barbara Channel spill was between one and three million gallons.

At least two different technologies are involved in the prevention and control of massive oil spills. One of these is the technology of marine transportation. The other is the technology for drilling and producing oil. Neither of these technologies, however, is presently adequate to prevent or contain an oil spill once it has occurred or for clean-up operations after an accident. The technology for control and clean-up involves ocean engineering, coastal or beach engineering, ecological considerations and a variety of other subjects.

During the research and development period and particularly before funding massive deployment of cleanup equipment, a cost analysis review should be conducted. A cost comparison should be maintained between the deployment of only minimal containment and disposal facilities with concomitant clean-up of each spill by present methods and the deployment of highly effective containment and disposal facilities. In other words, we should consider the possibility that effective containment and disposal may turn out to be vastly more costly than the cleanup of the few uncontrolled spills occurring after an intensive prevention and policing program.

Alternatives available to lessen the frequency and magnitude of oil spills do not include the complete abandonment of oil tankers or the total elimination of offshore oil operations. It is appropriate,

however, to examine the development, application and effect of controls and restrictions applying to these operations. It is appropriate also to examine how decisions should be made with respect to obtaining a balance between the need to develop a specific resource--oil-- and the need to protect the environment from undesirable accidents or side effects that may result.

In a sense, the oil spill problem joins the larger set of environmental problems facing society today. Some of the elements of the oil spill question raise more general questions of resource use, economics and allocation, of alternative or conflicting resource use, of developing technology for pollution control, of environmental quality standards, and of joint state-federal operations.

# COMBATTING A LARGE OIL SPILL

## Anatomy of a Program

The United States has neither the technical nor the operational capability to cope satisfactorily with a large-scale petroleum spill in the marine environment. The technology does not exist to prevent virtually all of the oil in a massive spill from being deposited on shore.

If a major program directed toward prevention of shore damage were to be initiated today, deployment of an adequate protective system might reasonably be expected within five years.

Therefore we urgently recommend that:

1. A research, development, and deployment program to control massive spills be funded and implemented immediately.

2. Operational shore cleanup capability be authorized and funded.

3. An information program be implemented to inform the public of the probability and predictability of oil pollution and of the existence and effectiveness of standby clean-up capabilities.

Detailed program needs to execute these recommendations include the following elements:

Oil Spill Surveillance is required for warnings, damage control, estimation of the extent of damage, assessment of the effectiveness of control methods and for research and development on oil clean-up. Fortunately there is considerable airborne technology available which may be adaptable to surveillance of oil slicks.

Techniques.

1) Optical-visual and photographic-observations are of value when conditions permit. They define limits of the slicks because of the disappearance of color when the thickness becomes less than the wavelength of light. This thickness is normally found to be the thickness of a surface oil film on the open ocean.

2) Ultraviolet imaging techniques are available, and tests conducted on the Santa Barbara spill indicate that they are useful. The wavelengths near 0.35 microns showed extent of oil very clearly in this case.

3) Particularly promising is the airborne use of both active and passive radar. The first method is very sensitive to the change of wave slope that occurs because of the influence of oil. The second is sensitive to temperature changes. Both could possibly be calibrated for oil thickness. These methods should be particularly valuable because they are operable under essentially all weather conditions. This method also gives data on local winds and seas.

4) Infrared images were not useful in Santa Barbara, but a more thorough test is needed.

While considerable experience has accumulated with these techniques and while much of it pertains to definition of oil slicks, there is no operational system available which can be deployed to obtain the precise data that are required for effective monitoring of oil slicks. We therefore recommend a mission-oriented R&D program aimed at developing a combination of perfected techniques that can be used by an operating team to monitor the spread of spilled oil, estimate the quantities involved, and confirm predictions developed from weather and current data.

Prediction. A very important adjunct of the surveillance program is the ability to predict the movement of slicks. This is a combined physical oceanographic and meteorological problem. Programs to integrate oceanographic and meteorological data and predict the movement of spilled oil should be developed.

Sampling and Identification. Information is available on techniques for identification of types of oil by chemical methods for use in determining the sources of spilled oil and the changes in its properties with time. These techniques can be applied directly to oil spill identification.

Containment, Removal and Disposal.

The Panel's views on containment, recovery, removal and clean-up of spilled oil are based on the assumption that deployment and use of equipment require mobility and adaptability to local equipment and ships. Readiness for rapid deployment is an important consideration.

Containment. Containment materials and equipment should be easily transportable and stockpiled in strategic locations. Containment should be accomplished close to the source, and must be integrated with a recovery capability to remove oil as fast as it accumulates in the containment system.

1. Booms can be designed to be effective at sea for a variety of wind, wave and current conditions. Booms should be designed that can be deployed and handled by ships readily available. Booms should be designed for use under open sea conditions with 8-12 ft. wave heights. Boom systems must also be strong enough for towing and deployment at sea. Research is needed to meet such conditions. Booms of lesser capability should be constructed and deployed as soon as possible especially for use in quieter waters of harbors and estuaries.

2. Research on air curtains should be considered but at a lower priority because the method appears less promising than mechanical booms. This technique should be pursued for use in confined or semi-confined areas.

3. Chemical containing and collecting methods including gelling agents, foaming agents and absorbents should be the subject of research with a high priority. Agents should be developed that can be stored or generated aboard ship for emergency use.

4. Important in the overall objectives is research on the ability to transfer oil from stricken tankers. Equipment such as large rubber or plastic containers to transfer oil from ships and air transportable, high volume pumps should be developed and considered as mandatory to ship or be available at critical locations.

5. Underwater methods to collect oil from subsea leaks should be developed. Rising bubbles of oil may be collected more easily by inverted funnel devices than by booms at the surface. Underwater collectors could be deployed over sunken tankers, or on the sea floor where natural or manmade leaks are causing pollution.

Recovery. Recovery of oil from a spill should be commenced promptly in conjunction with containment. Recovery of crude oil or crude oil mixed with water removes a pollutant from the sea and salvages a product of possible economic value.

Assuming barges or tanks or rubber-plastic containers are available for receipt of oil, skimming and pumping techniques should be developed which are adaptable to generally available ships.

1. First priority should be given to high volume pumping of oil from the surface of the sea followed by rapid separation of the oil from the mixture, returning water to the ocean. Centrifugal methods or gravity separation are considered most promising.

2. Further research is needed to find or develop absorbent materials which may be applied to the sea surface to contain spills and permit recovery of oil. Materials which are hydrophobic, absorb oil, have capilary action, are lightweight, and permit rapid oil extraction should be investigated to be used as surface sponges directly and as materials for boom construction. Absorbent materials of this type will probably be most applicable to intermediate size oil spills. Large blocks ("sponges") of this type of absorbant material may retain as much as 5 to 10 times their dry weight as oil, permit recovery of oil into a vessel, and immediate reuse of the material as an absorbent.

Open Sea Removal. If containment and recovery cannot be accomplished at the site of the spills other removal techniques should be considered.

1. A promising technique of removal of oil is sinking it by adsorbing it on fine granular material like chalk or sand. The kinds and extent of damage to bottom-dwelling organisms must be known before widespread application of sinking methods. Long term ecological effects must be considered. Readily available and economical sinking agents should be considered and given priority for research. Abundant substances such as soil or sea bottom materials should be considered. Soil can be broadcast by spreaders and bottom sands or

muds can be dredged up near the polluted area and sprayed on the slick. In areas where no valuable bottom organisms exist these methods could be tested immediately. Sinking methods should hold the oil at the bottom long enough to be biologically degraded.

2. Straw has proved successful but research on other absorbents such as foams, plastic capillaries, or other floating substances that can be widely broadcast and recovered (either on the water or along the shore) should be emphasized. Many such substances already available should be evaluated. New substances should be designed and fabricated. Effective methods of application should be developed concurrently.

3. An alternative clean-up method not yet explored would be use of absorbent particles which, unlike chalk, will not sink but remain suspended in a layer between 5-20 meters depth. This method would avoid contamination of beaches and bottoms by maintaining the oil in a zone rich in oxygen - a condition favoring bacterial degradation. Light and highly porous materials might serve the purpose especially if made hydrophobic.

4. Past efforts to burn oil spilled at sea have been ineffective. It is possible that techniques can be developed to assure combustion when oil is thinly spread on water.

5. The use of detergents and other emulsifiers to disperse oil in the marine environment is open to serious question. Dispersants do not remove the oil from the sea, and there is no evidence, at present, that bacterial degradation of the oil is accelerated. Detergents have often been demonstrated to cause more damage than oil alone because of additional toxicity to marine organisms, while not accomplishing effective and lasting dispersal. Detergents should be used only in local areas, in small quantities, under the authority of responsible state and local officials.

Clean-up. Floating absorbents inevitably will collect on and litter beaches. It is necessary to harvest and dispose of this material swiftly as it is sometimes highly inflammable. If not removed promptly it will also be admixed with beach sands.

Research is recommended to develop high temperature incinerators to burn all organic matter from oil soaked sand. Such incinerators should be easily transportable to polluted areas, use readily available fuel, be of high enough temperatures to burn the organic matter without air pollution, and allow sand to be returned to the beach.

It might be possible to design a travelling high-temperature burner that could clean sand in place. Such a machine would, or course, remove ordinary beach litter.

Oil and Environmental Effects.

The complete effects on the environment of spilled oil are not sufficiently well known and further detailed studies are badly needed. Effects on birds, larger wildlife, and natural beauty are easy to observe, but effects on unobtrusive animals, microorganisms, and the net effects on the food chain and the ecological habitats of marine wildlife are poorly known. Direct and indirect effects on plants are similarly poorly known. Some of the knowledge of toxicity and ecological effects of oil are summarized below.

Restoration. Following pollution by oil the need to restore aesthetic values and recreation facilities of the environment often conflicts with the need to minimize damage to living organisms from the toxicity of oil solubilizers and detergents. Both needs being important, actions taken should be a compromise guided by priorities. The cleaning of a marina may be more advisable than protection of fishing within the harbor; the cleanliness of a beach less important than protection of living organism even of minor economic value.

1. Until better means can be found for cleansing beaches, sea-water and rocks, the use of detergents should be limited to essential localized areas and they should be applied carefully to avoid accumulation of toxicity. Recolonization of damaged areas will be speedier if planned adjacent areas are left untreated and can therefore reseed the flora and fauna of the treated areas. The extent of damage varies according to the severity of pollution and the relative sensitivity of the organisms: some will be killed, others may proliferate from lack of competition.

2. The restoration of normal biota may take a few weeks to several years. It depends largely on the nature of the environment such as currents, flushing and nutrient turnover and on the type of organisms, such as the length of their life cycle, their abilities to migrate, to compete and reproduce.

Forecasting the extent of damage and time for recolonization is difficult because of the complexity of events, the variety of environments and biota, and especially because of a lack of information on the sensitivity of many species to oil and their competitive abilities during recolonization. Extensive research is needed to determine oil sensitivity of many organisms and to provide a more reliable index of damage from oil pollution than direct measurements of oil quantity, distribution or thickness.

3. It is also important to recognize that localized oil spills, perhaps even major ones, though impressive at the onset, rarely damage the environment permanently. On the contrary a widespread, low intensity, persistent leakage of pollutants is likely to make profound changes in the biota and the food web.

4. Local residents affected by oil spills are particularly sensitive to infringement on the aesthetic and the recreational use of their environment. Because of the pressures exerted by local communities to have a thorough clean up, involving the use of detergents, it is recommended that the Department of Interior carry out an active public information program to explain what is being done and why, and what the dangers are of certain practices.

Dispersants. It is well known from the Torrey Canyon incident that the toxicity of many detergents and other emulsifiers increases with effectiveness since effective dispersion depends upon solvents which are highly toxic. Other biodegradable emulsifiers are less toxic but still inhibit several algae at concentrations of 5-30 ppm.

The use of emulsifiers and detergents can be justified only if they are employed well out from the littoral zone and if local currents send the emulsifier-oil mixture further out to the open ocean. The use

of detergents on beaches, littoral zones, and harbors is more dangerous because, in making oil miscible with water, the oil will spread into the sand, and penetrate crevices, and the suspended emulsion will coat the body and gills of marine animals - surfaces which untreated oil would not "wet". Also, if the emulsion particles are small enough, they may be ingested and be harmful to some filter feeding invertebrates such as oysters and clams.

Search for effective, less toxic or harmless emulsifiers is highly recommended because they are needed in many clean-up operations.

Toxicity of Oil. We know too little about toxicity of crude oils and their long range effect on the biota. Toxicity of natural oil depends upon the quantity of volatile aromatics (generally 1-2% by volume is a toxic concentration) and of phenolic compounds, especially naphthalenic acids (present in lower concentrations but toxic at 10 parts per million). Since crude and fuel oils vary widely in their components, each type should be analyzed chemically and bioassayed for toxicity to living plants, bacteria, and animals.

Fresh oil, depending on its content in phenolics and aromatics, may be injurious to the biota at 0.01 - 1% and toxic at 0.05 - 5% by volume. However, the toxicity of fresh oils declines rapidly in the first few days after a spill since the aromatics are volatile and the phenolics, being water soluble, may become diluted well below toxicity. Disappearance of toxicity of fresh oils is favored by winds, rough seas, spreading in thin layers on large volumes of water and by insolation. After disappearance or dilution of the toxicants, oil seems to be non-toxic in pelagic waters and does not seem to affect oxygen transfer substantially, even in layers 1/2 inch thick. However, oil is deleterious, even lethal, if it coats furred or feathered animals. Cleaning up of birds is ineffective because treated birds at present rarely survive.

Present data are derived mostly from observations on accidental oil spills; thus we lack accurate information on the biota before and after the spills. The Torrey Canyon observations, because of the large use of dispersants, furnished valuable data on the effect on the biota of combined oil and dispersants but these observations do not provide data on the effect of oil alone.

A good study of the effect of a fuel oil spill followed the stranding of the Tampico Maru in Baja, California. The entrance of the small shallow cove (90,000 square feet) was 3/4 blocked by the ship; thus the exchange of cove water with the open sea was severely reduced. The cove was subjected at shipwreck to an initial spill of 20,000 barrels of dark diesel oil and to further spillage of the remaining cargo (40,000 barrels) which occurred sporadically during 8 months. Diesel oil is more toxic than most crude oil. Large animal mortalities ensued, resulting in over development of sea weeds. After nine months many animals had reappeared. Reestablishment of most of the biotic community occurred in 2-4 years after the catastrophe despite the fact that the waters were also polluted by the metallic debris resulting from complete disintegration of the ship 9 months after the wreck.

Assessment of Biotic Effects. Improved laboratory bioassays are necessary for determining the toxicity to marine organisms of various crude and fuel oils, of dispersants, and the mixture of oil and dispersants. These should be commenced now on plants and animals that can readily be held in the laboratory. As our cultivation techniques improve the assays should be done on the more sensitive species.

A final assessment of the effects of oils and dispersants should be done in natural environments suited for comparative experiments. Monitoring of these experiments should be followed at least for one year to detect long range effects. Studies on the fate of oil which accumulates on the bottom after sinking with chalk or other materials are needed.

Ecological Research. We recommend that a plan for initiating and coordinating ecological research following oil spills be established as part of each Regional Response Team being organized under the National Contingency Plan. Centralization and organization in a Federal Agency or large university should serve to cover applicable avenues of research that appear important. Planning for and identifying a group of experts prepared to respond quickly will increase the chances that the important information will be gathered. A centralized organization in the government or a large university should be responsible for arranging for publication of individual reports and syntheses, thus putting the problem, its solution and its prevention into perspective.

Organizational Requirements.

Federal. There are a number of federal agencies with defined responsibilities in connection with oil pollution control. Amongst these are the Federal Water Pollution Control Administration and Geological Survey in the Department of Interior, Office of Emergency Planning, the U. S. Coast Guard and the U. S. Army Corps of Engineers. The Joint Department of Interior-Department of Transportation report to the President of February 1968 points out the need for further actions and responsibilities for control of oil and other hazardous substances. A National Contingency Plan for combatting spills of oil and hazardous materials has been promulgated and regional plans are being developed. Legislation pending before Congress would strengthen the federal role in the prevention and control of pollution by oil. Despite the actions now underway the Panel concludes that the constituted authorities cannot exert full effectiveness in the control of oil pollution incidents or an imminent pollution incident. The following legislative, administrative and resource allocations are recommended:

(1) The Federal Agencies should be provided legal authority to exert jurisdiction and control over a pollution incident and to preempt operational responsibility from the party responsible for the pollution incident when the public interest is threatened. This capability should be independent of any determination of which party or parties are legally responsible for control of the pollution source.

(2) Adequate funds should be immediately available for use by the on-scene commander to carry out his responsibilities for containment, control, and cleanup of oil spills.

(3) The rights, duties, and limits of liability of the party or parties having responsibility for the pollution source and of the appropriate public agencies require legislative definition to assure that

(a) the least careful operator will be forced to raise his operations to a level generally deemed prudent, and
(b) redress be provided to the injured party or parties even at the level of national disaster.

(4) Enforcement mechanisms under existing or new legislation require improvement to insure that violators are subject to either civil or criminal action as appropriate (e.g. the Panel has been led to believe that no successful actions for pollution violations have ever been prosecuted under the oil pollution act of 1924 as amended.)

(5) A national oil and hazardous materials information and data center should be maintained to assist contingency planning, to aid in identification of sources of equipment, material and expert assistance on a rapid response time to combat pollution accidents.

(6) Operational hardware should be acquired and operational units trained and manned to a level which will provide a national capability to contain, control, and cleanup spilled oil and other hazardous fluids regardless of size and location.

Regional and State. Through the National Interagency Committee there are in preparation regional plans which identify Regional Operational Centers and Regional Response Teams. In recognition of joint federal-state jurisdiction which may be in effect at a source of pollution and the right and responsibility of the States to prepare independent plans and capabilities, -- it is the recommendation of the Panel

1. (a) that regional contingency plans be expeditiously completed and field tested;

   (b) that these plans provide mechanisms for inclusion of local and regional expert advice at an early stage of an operation;

   (c) that these plans provide mechanisms for receipt and dissemination of public information and evaluation of proposals for assistance; and

   (d) that these plans incorporate regional environmental and ecological factors (e.g. ice, tidal anomalies, seismic activity, wildlife sanctuaries) as significant elements of contingency planning.

2. In view of the uncertainty and the nature and type of future incidents, an early identification and clarification of possible conflicts between federal and state statutes and regulations should be undertaken.

International. In some instances (e.g. the Great Lakes) an oil spill may affect another country besides the United States. Thus international agreements should be negotiated, especially with Canada and Mexico, for control of pollution incidents.

Industry. In recognition of the prime responsibility of industry to prevent pollution incidents and its right to limit its liability by taking independent action in the event of an incident and recognizing the existence of industry expertise and hardware capability, the Panel recommends

(1) that the formation of industry association committees, research organizations and development capabilities be encouraged and that mechanisms be provided for coordination with government activities,

(2) that mechanisms be provided for insuring that the advice of other interested parties such as holders of riparian rights, conservationists and other interested and effected citizenry be made available to the National Interagency Committee at a level comparable to the advice which is received from industry,

(3) that legislation be provided (if necessary) to insure that industry will furnish sufficient details on a pollution incident or impending incident and the environmental and physical factors associated therewith in a timely manner to the appropriate authority,

(4) that the sharing of pollution control research, development and equipments by industry be encouraged and that appropriate legislative relief be provided if such sharing is at present prohibited by law.

Need for National Overview. As stated, responsibilities arising from oil pollution of the environment reside in several federal agencies (i.e., USGS, USCG, FWPCA, Corps of Engineers). Moreover, oil pollution is also a primary concern of industrial associations such as the American Petroleum Institute and the Western Oil and Gas Association, shipping associations, pipeline groups, etc. In addition, many state, local, and independent agencies are involved in the complex

subject of oil utilization. Although the relevant federal agencies have formed a National Interagency Committee on oil pollution to effect liaison and coordination, this is an "in-house" group without representation from industry, local or state government, or the general public. There appears to be need for a quasi-independent advisory group on oil pollution to provide an overview of this subject for the benefit of the President, the Congress, and the public at large.

We recommend, therefore, that a National Advisory Board on Oil and Hazardous Fluids be established to report periodically to the President and to advise the National Interagency Committee with respect to policies, programs, and plans relative to the prevention or mitigation of pollution from transportation, processing and utilization of oily substances and other hazardous fluids.

This Board should comprise 12 to 15 members who are not fulltime Federal employees. They should be selected from industry, universities, private practice, and possibly from state or local government. They should embrace professional disciplines such as marine and petroleum engineering, oceanography, environmental engineering, public health, chemistry, ecology, economics and law. It is expected that the Board would meet frequently to review the policies, practices, and plans for all agencies that interface on the oil pollution problem. The Board should not attempt to certify, approve, or reject each individual operation, but instead it should be concerned with broad policy for standards, control mechanisms, supervision, inspection, monitoring, safeguards, emergency plans and other processes related to potential releases of deleterious fluids into the environment.

## AVOIDING OIL SPILLS

Every day the vast quantities of oil which must cross the shores of the United States provide the potential for a massive oil spill. Whether this oil reaches our shores in tankers or is piped in from offshore producing facilities affects only the details of possible spills. The hazard is present in either case but the potential size of one spill is many times greater in the tanker case. Tankers carrying 30 million gallons now unload at our ports. Announced plans call of 150 million gallon tankers.

The anticipated hazard of major oil spills in the ocean environment from offshore oil producing operations is very real also, but of a lower frequency in the past than from tanker operations. The hazard is present from accidents in drilling and producing operations and from severe environmental conditions imposed by weather, ice, and possible earth movements.

### Transport by Tanker - Prevention of Oil Spills.

Industry and responsible government agencies have been working for years on national and international levels to prevent pollution by oil from ships at sea. The Panel's review noted particularly agreements reached through the International Maritime Consultive Organization and the studies and plans now underway on such subjects as shipment of hazardous materials, navigation, safety and ship design. A careful analysis has been made by the Department of Transportation on the technical requirements for design and ship movement to reduce the potential for spills of hazardous fluids. This is described in the joint report of the Department of Interior and Department of Transportation on Oil Pollution.

Despite the foregoing actions it is the view of the Panel that in order to reduce the potential for pollution, adequate controls still do not exist on the design, manning, operation, regulation, inspection and legal liabilities of tankers and other conveyances for the transfer of oil and hazardous fluids on the high seas, on coastal waters subject to international jurisdiction and on internal waterways. In particular the following examples are noted:

(1) The design of tankers may not in general be optimum for the containment of oil following collision or other accidents at sea, nor for emergency off-loading on the high seas.

(2) Under international law sovereign powers cannot interfere with or preempt normal salvage operations in order to minimize pollution hazards.

(3) Under current international law sovereign powers may not direct the coastal approach of distressed ships with the potential of creating a pollution hazard until the vessel enters the contiguous zone or territorial sea of the affected nation.

In view of the foregoing and in recognition of the increased potential hazard from massive oil spills that can result from accidents involving tankers, the Panel recommends:

(1) That the United States, in its present and future representations and negotiations and in positions taken with international organizations such as IMCO and conferences on the Law of the Sea, give new stress and priority to the prevention of pollution in all recommendations involving ship design, navigation, safety, training, and general operations of tankers on the high seas.

(2) That the U. S. Coast Guard in its ship inspection and certification program and in its future research and involvements in tanker design and operations give added attention to prevention of massive oil spills. This might include expanded studies on the sizes of tankers, the number and arrangements of tanks, the development of emergency equipment, and other items from the point of view of oil containment as well as safety of operations.

(3) That further study be made on designation of sea lanes for control of tanker routing and that steps be taken to develop and implement a U. S. plan for avoidance of hazardous or unique areas by tankers carrying oil and other hazardous substances. Every effort should be made to make use of designated sea lanes mandatory rather than at the option of the tanker Captain.

(4) That an analysis be made of existing law and of pending legislation with the aim of granting sufficient authority to appropriate federal agencies to take control of and assume liability for a pollution event when it is evident that there is a threat to public interest.

(5) That standards for operation of supertankers in U. S. waters and ports be developed and that such standards of operation be implemented through international agreement.

(6) That training programs for all maritime crews be improved to reduce human error as a major cause of pollution accidents and that future curricula of the U. S. Merchant Marine Academy include instruction in ways to prevent pollution by oil.

(7) That procedures for handling fuel oil and oily wastes of all ships be reviewed and modified as required to reduce the hazards of spills.

Offshore Oil Development and Environmental Hazards.

Part II of the Panel report on development of offshore resources presents policy issues on oil operations. However, some observations and findings pertinent to offshore oil are offered in this part of the report.

Submerged lands of the Outer Continental Shelf off the United States are leased to industry on a competitive basis by the Secretary of the Interior for development of oil, gas, sulfur, and other minerals. Lease sales are usually held following nominations of tracts by industry or upon the Department's motion which follows known industry interest in resources. Under delegation of authority from the Secretary, leases are issued by the Bureau of Land Management. Exploration and technical operations of drilling and production are authorized and supervised by the Geological Survey.

Offshore oil platforms are operated under regulations issued by the U. S. Coast Guard to promote personnel safety and reduce hazards to navigation. The placement of platforms to prevent obstruction to

navigation on the outer continental shelf is reviewed and authorized by the Secretary of the Army through the Corps of Engineers. Authority for the foregoing stems from the Outer Continental Shelf Lands Act, (public law 212, 83 Congress). Under this Act the Secretary of the Interior holds the prime responsibility on behalf of the Federal Government for safety of engineering practices, prevention of pollution, and management of offshore operations to reduce interference with other interests.

Development of resources under offshore submerged lands has depended largely on industry initiative. Geological and geophysical explorations have been carried out by industry over periods of many years before new areas were opened for lease. For example, the first explorations offshore in the Santa Barbara Channel commenced in 1945. In recent years geophysical, seismic and environmental data have been collected by industry in the Gulf of Alaska and along the Atlantic Coast of the U. S. in long range programs to discover new reserves of petroleum. Lease of tracts within fields already under development depends upon information obtained from drilling in adjacent areas. Because lease sales are competitive, information and data on the geologic nature of possible oil-bearing formations are held proprietary by industry and are not usually available to government until their use is of no further value in an economic sense.

From the point of view of geologic structure and oil-well technology, there are few (if any) coastal oil fields that are especially more hazardous than others at the well-sites. Nevertheless oil fields differ in their problems and requirements. The vertical sequence of rocks and their characteristics and structural conditions of the continental shelves of North America are known only by inference and extrapolation before drilling. These uncertainties, which should control drilling practices, will not permit intelligent predrilling evaluation of specific areas or structures with regard to the special problems they present. However, because of variable oceanographic characteristics and differing beneficial uses of the ocean, the potential consequences of environmental degradation in case of well leakage are highly variable. Therefore, some situations require much higher standards of operation and supervision than others in order to preserve the environmental qualities at desired levels.

In recognition of this the Panel therefore recommends that:

1. Oil well operations be conducted under stringent regulations and supervision using the most up-to-date technology in order to minimize the possibility of leakage.

2. Particular attention should be given to the experience and training of drilling supervisors in offshore drilling to assure that a qualified, experienced expert is present on site during all operations.

3. Any oil companies holding offshore leases be required to show their capability for control, containment and removal of spilled oil from the sea in the vicinity of any leak to the responsible agencies.

4. In view of the complex and sometimes uncertain jurisdictions covering pipelines which cross international jurisdictions and the joint responsibility for regulation by Federal and State Agencies a study should be made of the status of pipelines to clarify regulatory responsibility and to achieve improved pollution control in installation and operation.

## Bibliography

"Oil Spillage Study Literature Search and Critical Evaluation for Selection of Promising Techniques to Control and Prevent Damage." Battelle Memorial Institute, Richland, Washington, November 1967. Distributed by Clearinghouse for Federal Scientific and Technical Information, U. S. Department of Commerce, Springfield, Virginia 22151. Contains an extensive bibliography.

"Oil Pollution - A Report on Pollution of the Nation's Waters by Oil and Other Hazardous Substances." A Report to the President by the Secretary of the Interior and the Secretary of Transportation February 1968, 31 pp. Contains a selected bibliography.

Smith, J. E. "Torrey Canyon Pollution and Marine Life" A Report by the Plymouth Laboratory of the Marine Biological Association of the United Kingdom. 1968, 196 pp. Cambridge University Press. Contains a selected bibliography of European literature.

McKee, Jack E. "Oily Substances and their Effects on the Beneficial Uses of Water" State of California Water Pollution Control Board Publication 16, Sacramento, California 1956, 71 pp. Contains a comprehensive bibliography of earlier work.

## Acknowledgements

The Panel wishes to express its appreciation to the several organizations and many individuals who contributed extensively to this study on oil spills. We are especially indebted to the Department of Transportation, U. S. Coast Guard for furnishing expert advice and for special airplane flights on which the Panel Members viewed the spread of oil slicks over the Santa Barbara Channel. The Department of the Interior through the Geological Survey and the Federal Water Pollution Control Administration rendered valuable assistance in meetings and furnished valuable data and information relative to pollution control and offshore oil operations. We are indebted also to the National Petroleum Council for special analyses on oil production and for reports on industry cooperation. We are indebted to officials from the State of California and to members of the faculty of University California Santa Barbara for presenting their views to the Panel.

The Panel was greatly impressed by the number of State, Federal and industry activities that were underway to combat pollution by oil at the time its own studies were commenced. The existence of this extensive work made it possible to draw upon a large body of information and thus facilitate completion of the task in a relatively short period of time.

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price 35 cents

GPO 882-052

COASTAL ZONE
INFORMATION CENTER

DATE DUE

GAYLORD No. 2333 PRINTED IN U.S.A.

NOAA COASTAL SERVICES CENTER LIBRARY
3 6668 14105 9651