ASSESSMENT OF FACTORS THAT MAY CONTRIBUTE TO OIL SPILLS

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Assessment of Factors That May Contribute To Oil Spills

The following outline is a generalized accounting of various factors that should be considered in the leasing of the Mid-Atlantic and North Atlantic areas.

The bibilography attached is a quick appraisal of sources that can provide needed general information. Obviously, much more information on specific aspects is available, and the work done by the NYS Geological Survey represents a major effort in identifying possible information sources, especially with geologic hazards.

The intent of this technical memorandum is to highlight some of the natural conditions in these leasing areas that might otherwise be overlooked when examining an environmental impact statement or a lease stipulation.

I. Present Oil Spill Trajectory Studies for Baltimore Canyon and Georges Bank

In the past few years, a number of oil spill models have been mathematically derived to predict where an oil spill will travel given a hypothetical spell location. It should be remembered that the models, seven in all:

(1) MIT, Stewart, Devanney, and Briggs, 1974
(2) MIT, Devanney and Stewart, 1974
(3) U.S. Coast Guard, Lessauer and Bacon, 1975
(4) U.S. Coast Guard, Miller, Bacon and Lessauer, 1975
(5) Hardy et al., 1975
(6) Brookhaven National Laboratory Model
(7) U.S.G.S., Smith, Slack, and Davis, 1976

are theoretical mathematical models. All models are simplified, one dimensional, wind-driven systems. They assume that the water column is homogeneous and do not consider other important oceanographic factors such as mixing, long shore pressure gradients, long shore drift, density differences, upwelling or settling out in the water column.

At present, the most extensively used models are the U.S.G.S. models. These models are the basis for prediction and transport of spills and environmental impacts for the Department of Interior, Bureau of Land Management, environmental impact statements. However, the analyses that are utilized consider the amount of undiscovered, economically recoverable resources in the specific lease sale only. For example, the Mid-Atlantic analyses which appeared in Final Environmental Impact Statement for Lease Sale #40 were predicated on the fact that the resource find would be 1.4 billion barrels over the life of the field. Secondly, the analyses dealt with spills within the lease areas only. Thus, a pipeline spill or a tanker spill closer to shore was not included in the analyses. For the North Atlantic area a maximum of 650 million barrels of oil was used as the basis for analysis.

To accurately assess then, the potential for oil spills and possible impact upon the resources of New York State, a combination of these studies must be utilized to predict (1) spills originating and transported from the lease areas and (2) spills originating and transported outside of the lease areas.

II. Transport of Spilled Oil

A. Dispersive Processes

Over the Continental Shelf, the paths of spilled oil depend on the following dispersive processes: dissolution, evaporation, emulsification, spreading, drifting and sinking.

-degrees of dissolution, evaporation, and emulsification are determined primarily by the kind of spilled oil and its physical state, water temperature, wind and surface mixing are secondary factors.

-the processes of spreading and drifting, on the other hand, depend largely on the quantity of spilled oil, the horizontal and vertical water movements, and the duration and velocity of the winds.

-moreover, oil sinks after its density is increased by the loss of the volatile and light fractions or by the inclusion of suspended solids; the rate and the depth of descent may be affected by the thermohaline structure of the water.

Paths of spilled oil depend primarily on the temporal and spatial variability of four factors:

1) the thermohaline structure of the waters
2) the circulation of the water
3) the winds
4) the distribution of suspended matter

Thermohaline structure of the waters - measurements of temperature and salinity; knowledge of the monthly or seasonal thermohaline structure is probably most useful for predicting the movement and effects of spilled oil.

Circulation of the water - tides and tidal currents measurements can be used to determine the tidal characteristics at any desired location near the coast.

Winds - in the event of a spill, wind stress would not only modify the water circulation, but would act on the surface oil film directly.

The distribution of suspended matter - the movement and dispersal of spilled oil may be aided by the inclusion of suspended matter; the density of oil may be increased by the incorporation of particles at sea surface, and, consequently, oily debris may sink to intermediate water depths or to the sea floor.

1. Baltimore Canyon - Knowledge of the monthly or seasonal thermocline structure is probably most useful for predicting the movement and effects of spilled oil. The thermocline structure of the Baltimore Canyon Trough Area is determined primarily by seasonal changes in solar insolation, winds, runoff, and indrafts of slope water. Tidal currents are relatively unimportant in determining the net drift of spilled oil within the Baltimore Canyon Trough Area. The winds and circulation of the water are two of the factors that may effect or influence the movement and dispersal of spilled oil, however these factors are inadequately defined by existent data. Therefore, the movement of potential oil spills in this area cannot be reliably predicted. Suspended matter is probably not an important dispersive agent for spilled oil in the Baltimore Canyon Trough area because of its low concentrations and biogenic composition (characterized by low density) within the surface waters.

2. Georges Bank - The movement of potential oil spills in the Georges Bank area cannot be readily predicted, as observed in the Argo Merchant spill. It is inadequate to use look-up tables for currents combined with statistical models of wind, or vice-versa. In the near-shore environment, the winds and currents are too highly correlated for the above approach to be adequate.

B. Probability of an Oil Spill Coming Ashore

Given that there will be a number of large spills on the Atlantic OCS in the Georges Bank and the Baltimore Canyon, the obvious question is what will be the impact of these spills? Although there will be a number of smaller spills, the spills greater than 1,000 barrels will produce the most problems. While not discounting the smaller ones, these spills will occur on the Continental Shelf in deep water where they can be actively dispersed by wave and wind action. The releases of chronic discharges and other environmentally foreign substances such as drilling muds will be dealt with later.

From the numerous studies and models to date, it does not appear that New York State will be adversely impacted by a large spill, given that the spill will occur in the present leasing areas. However, it should be noted that these are purely hypothetical mathematical models based primarily on wind direction. If spills occur outside the lease area, for example in the Nantucket to Anbrose traffic lane, the chances of a spill reaching Long Island are greatly increased.

It should also be noted that the primary focus of the coastal states is to assess the probabilities of a spill reaching its shore and/or the resources in its own coastal zone. Obviously, this kind of spill would have a major impact - both environmentally and economically - on the states' resources. A recent study, done by the Office of Parks and Recreation as part of the State's OCS program, estimated losses of between $25-30 million to the tourism and recreation industries as a result of an incident (summer, 1976) when a great amount of debris washed up on the beaches of Long Island.

The following table is a synopsis of data presented in the Final Environmental Impact Statement for Lease Sale 40, on the seven previously mentioned oil spill trajectory models and studies. These trajectory analyses discuss the probability of a spill reaching the shore, the average time to reach shore, and the minimum time to reach shore.

Table
Probability of Impacting Long Island Shore

Stewart, Devanney, and Briggs 1974	25% - spring 8% other seasons
Lessauer and Bacon, 1975	Spill impacts shore in 4-8 days
Miller, Bacon and Lessauer, 1975	When summer high pressure remains stationary for 4-5 days then spill comes ashore When winter storm stalls and becomes stationary south of spill sites, there is a high chance of spill impacting shore
Devanney and Setwart, 1974	South of 40^{o} N latitude: less then 10% probability of impact in winter; less than 50% probability of impact in summer
Hardy et al. 1975	In winter months, 0% probability of a spill stranding on Long Island if more than 10 miles offshore In summer there is greater than 0% probability of a spill stranding on Long Island within 60 days if the spill is within 30 miles offshore
Brookhaven National Laboratory	Probability of impact is very low if the spill is greater than 15 miles offshore
Smith, Slack and Davis, 1976	70% probability of 7 major spills 10% probability of spill impacting shore 90% probability of pipeline spill impacting Mid-Atlantic shore

1. Baltimore Canyon Trough - Spill reaching possibilities are a function of the season - the summer and spring present the greatest probabilities of oil coming ashore - this is especially important because spills from EDS 5 and 6 could affect the recreation-intensive Long Island and New Jersey coasts. (See Map)

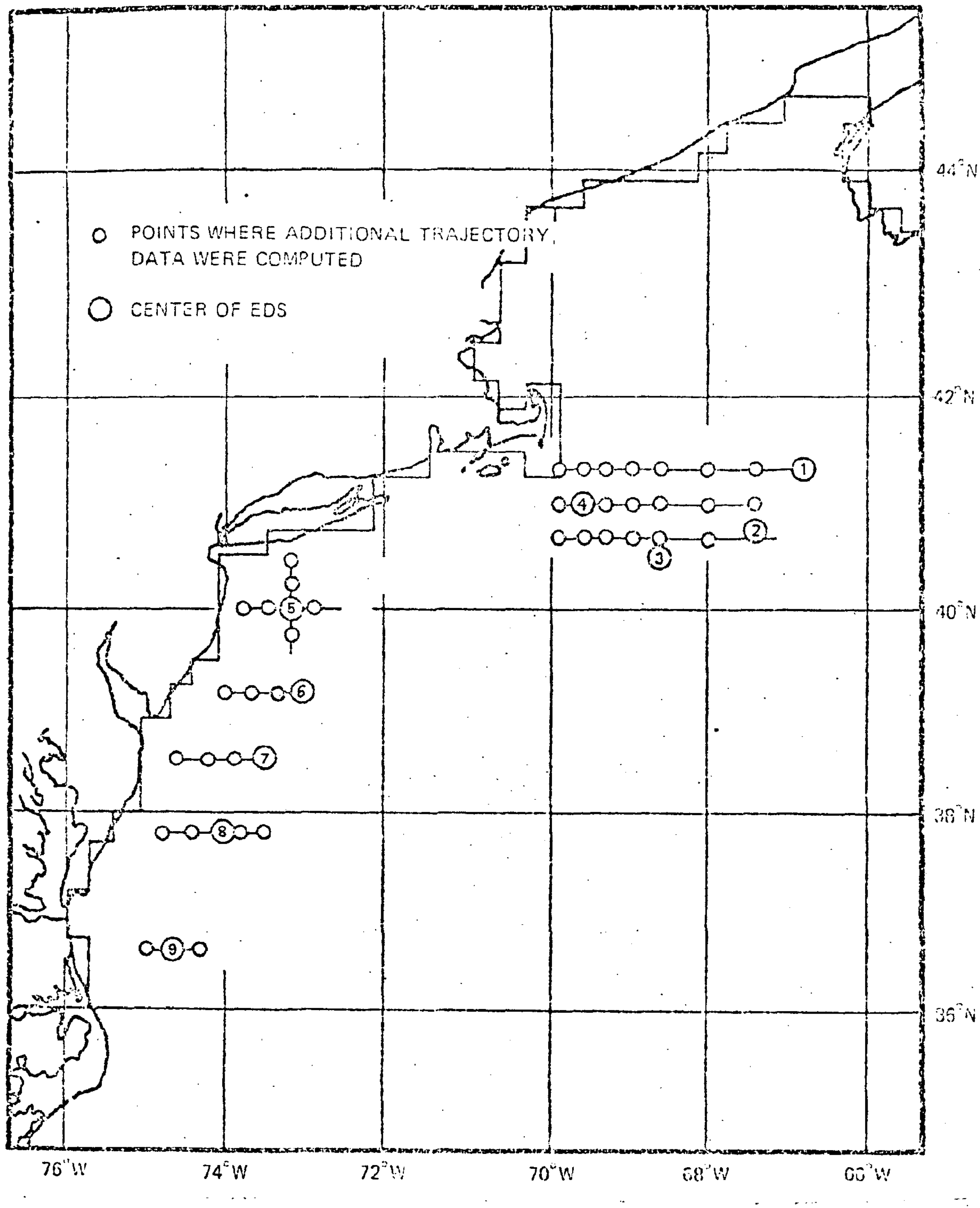
The mean time to land under winter, spring, and autumn conditions is about 16 days as opposed to about 25 days under summer conditions. Thus while summer spill trajectories, on the basis of wind and current direction, appear to be more likely to eventually come ashore than spills occurring in other seasons, the considerably longer times required to make the trip suggest that perhaps summer spills are actually of less concern.

2. Georges Bank - Average times for a spill from the Georges Bank to reach shore range within 40 and 129 days. Most oil spills at the Georges Bank sites are likely to come ashore near Cape Cod. For the Georges Bank area the probability of oil spills coming ashore from the four drilling site centers is fairly low. EDS 4 presents the greatest threat, with oil reaching shore about 50 percent of the time in spring.

III. Examination of Activities That May Possibly Disrupt The Transport Of Oil from the Outer Continental Shelf

A. Shipping Lanes

Traffic control measures, such as lanes, could be introduced in the future if warranted. Also a much wider use of radar reflectors or transponders may eventually be in order. Lighting and sounding devices on platforms are under the jurisdiction of the U.S. Coast Guard. Fixed platforms and rigs must be properly lighted by law. Fixed platform locations would be given U.S. Coast Guard's "Local Notice to Marines." Their presence should create no qualitatively new navigational hazard. A fixed platform which is identified on navigational charts is less of a hazard for collision than a moving ship whose presence is unexpected, and certainly no boat should be regularly operating in such offshore areas without operable radar, radio, and Loran.



Estimated Drilling Sites (EDS) Used in Oil
Spill Trajectory Studies
(Massachusetts Institute of Technology)

Source: Final Environmental Impact Statement - Lease Sale #40

The Ambrose-Nantucket traffic lane runs along the Long Island coast, coming as close as 15 miles in certain areas. There has been some discussion concerning moving the traffic lanes.

1. Baltimore Canyon - The placement of rigs and platforms on those portions of blocks that are within traffic lanes should be prohibited. Ships, especially foreign fishing ships and small craft, however, do not always use these traffic lanes, which increases the possibility of a collision with drilling rigs, permanent platforms, and for vessels attending these platforms.

At night and especially during rough weather, fog and heavy seas, ships not following the traffic lanes could collide with fixed structures. There also may be a possibility of fishing vessels "pulling up" anchors in storms and ramming into platforms. If fixed structures, including subsea completion systems and temporarily shut-in wells, are located on fishing grounds, fishing boats engaged in trawling activities will be inconvenienced by having to detour around these structures.

2. Georges Bank - During the first phase of oil and gas production it is expected that there will be a negative impact on ship traffic which will be short and disruptive in nature. Some conflicts may arise from vessel movements in the vicinity of major traffic areas caused by the additional number of vessels engaged in exploratory an investigative activities. In the process of performing investigative analysis, exploration vessels will not be traveling in the customary traffic patterns, but will be crisscrossing some areas which will increase the probability of vessel collisions.

B. Bottom Trawling Operations

Fishermen view debris as the most severe threat to fishing grounds and pipelines as the second most severe threat. They also feel that supply boat traffic should be confined to traffic lanes.

1. Baltimore Canyon

The majority of bottom fish and some shellfish species, such as scallops, are harvested by bottom trawls. Sites occupied by drilling or production platforms, attendent service boats, and tankers would consequently interfere with these activities.

Trawling operations in the Mid-Atlantic region occur in depths from 40 to 185 meters. Since there would be tracts leased at these depths, structures located in the region would have an impact on trawling operations.

2. Georges Bank

The majority of fish and shellfish harvested by commercial fishermen on Georges Bank are harvested by bottom trawling or dredging. The placement of platforms and pipelines as a result of the proposed North Atlantic oil and gas lease sale will restrict or remove some portion of the fishing area on Georges Bank now being utilized by the commercial fishery.

Otter trawls are the primary method of trawling on Georges Bank, with several modifications of trawl type used depending upon the nature of the bottom encountered. The maneuverability of a vessel once a trawl is in use is much impaired.

At least 162-1296 acres could be removed from commercial fishing during the exploratory stage.

There is poor manuverability of fishing vessels once they are actively trawling or dredging.

Most of the potential spatial interference that could be caused by OCS development would appear to be with the trawling of yellowtail flounder grounds.

IV. Assessment of Natural Phenomena and Other Natural Events That May Contribute to Oil Spills

An analysis of how operations would affect the environment in the Atlantic is incomplete without discussing the natural phenomena that could impact operations in Baltimore Canyon and Georges Bank. The environments of both areas are at times subject to the stress of severe storms, fog, and earthquakes.

A. Climatic and Oceanographic Conditions

The climate and meterology of North Atlantic is characterized by frequent weather changes.

Maine to Cape Cod - locally thunderstorms and a rare tornado will produce high winds; on the average, tornadoes probably occur at least once a year, predominantly in July.

Major low-pressure storm systems usually move through the region in a north to east-northeast direction and are often accompanied by strong, gusty winds and heavy seas.

Storms with sustained winds of at least 100 knots can be expected to occur once over a 90-year period in the North Sea, whereas in the Gulf of Alaska the period would be 50 years, and in the Middle Atlantic it would be 30 years.

Significant wave heights of 55 feet can be expected during a 25-year period in the Atlantic-in fact, the highest significant waves were reported off the Middle Atlantic Coast where 60 to 70 foot waves were encountered (Tetra Tech, Inc., 1973); significant wave heights of 55 feet can be expected during a 100-year period in the North Sea.

The density structure of the water column, the speed and direction of surface currents and winds and the weather extremes possible on the northeast Atlantic Shelf are highly variable short-term natural phenomena. Unlike geological factors, they can be predicted only in a statistical sense, and the actual conditions at any time may differ considerably from what the probabilities suggest. Thus any predictions, particularly those such as spilled oil trajectories that are generated by mathematical models based upon statistical probabilities, must be interpretated with caution.

Cyclonic storms of both tropical and non-tropical origin provide dramatic exceptions to the local wind patterns, with high-velocity winds rotating counterclockwise around a migrating low pressure center. Tropical hurricanes, with winds over 65 knots, average one or two a year and have been observed in the area from June to November although the peak occurrences are in late summer and early fall. From October to April the shelf is one of the hemisphere's major areas for notheast gales which intensify rapidly as they move northeast from Cape Hatteras gaining energy from the strong temperature gradients of the winter sea surface.

Weather statistics for the shelf, combined with the long distance offshore of probable production sites, suggest that present cleanup equipment will not be generally useful in the event of an oil spill. Boom containment is not effective in waves higher than about 5 feet. In summer this height is exceeded 10-20 percent of the time and in winter 40 to 60 percent, increasing from west to east (although the spilled oil itself would help calm the seas). Most spills would occur more than three hours from a staging area. Consequently, even under calm conditions a spill would probably spread over a large area before it could be contained.

B. Visibility

During the summer, fog may be a problem, especially in the North Atlantic. Incidence of fog is greatest in late spring and early summer when warm moist oceanic air is blown in over the still-cold surface shelf waters and condensation occurs. The hazard increases toward the east; in the Baltimore Canyon Trough region visibility less than half a mile occurs about 5 percent of the time in the fog season; from Long Island to Nantucket Shoals about 13 percent and over Georges Bank perhaps 16 percent for one day out of six.

Fog is a hazard, particularly as small wooden fishing boats are relatively poor radar reflectors. (Large steel platforms, on the other hand, are excellent reflectors.)

Fogs often set in almost without warning, and have been known to persist for 3 weeks almost without interruption.

North Atlantic - visibility reduction due to fog is most prevalent during the months of May, June, and July. During this period, fog and haze may reduce visibility to less than two miles, 25% of the time. No such quantification can be made for other operating areas due to a lack of reliable data for comparison. Conditions that result in a reduction of visibility may briefly limit helicopter supply activities and slow down boat movements, but such conditions should not interfere with day to day drilling or production activities. It must be borne in mind, however, that the North Atlantic OCS is subject to intense utilization by fishing and shipping activities. Reduced visibility has the potential of increasing the number of collisions between vessels and offshore structures.

C. Earthquakes

The United States Geological Survey rates the Georges Bank Basin and Baltimore Canyon Trough as having a moderate seismic hazard in comparison to the rest of the United States. Earthquakes comparable to about Richter magnitude 7.0 have been reported in the last several centuries. Earthquakes of this magnitude could damage most OCS structures and would damage foundations possibly to the point of collapse. Ground cracking would occur and landslides would develop. Earthquakes of 7 Richter or greater are predicted once every 100 years in the Atlantic and about every 3 to 5 years in the Gulf of Alaska.

1. Middle Atlantic - earthquake risk is slight to moderate for this area in comparison with most operating regions (such as southern California and the Gulf of Alaska). The main factors in an earthquake are the magnitude, duration, and the interaction of the soil structure system. In the near and offshore environment, the following events may take place: liquefication, submarine slides, slumping, turbidity currents, and geologic structural instability. In the Mid-Atlantic OCS, earthquakes represent a remote, but potential cause of an oil spill.

Given the fact that the upper sediments of the Mid-Atlantic sea floor rest on lagoonal sediments and buried river channels are also present in the leasing area, fluidization of fine sediments with high porosities or void spaces during an earthquake might result in damage to structures or possible oil spills during an eathquake.

2. North Atlantic - earthquake risk for this area in comparison to most operating regions is slight to moderate. Given the facts that upper sediments of the North Atlantic sea floor contain silt and clay layers and buried river channels are also present in the leasing area, fluidization of fine sediments with high porosities or void spaces during an earthquake might result in damage to structures or possible oil spills during an earthquake.

Damage from earthquakes is usually due to either structural failure caused by dynamic shaking or foundation failure due to loss of soil stability or strength. The loss of soil stability will have a damaging effect on all fixed structures. The most serious oil spills will be due to pipeline failure and collapse of underwater storage tanks.

V. Pipeline Siting and Safety

Assuming that all OCS pipelines will be buried under the ocean floor to avoid being ruptured by vessel anchors or propellers, some vessel risk will remain due to:

(1) bottom sand shifting

(2) occasional line exposure for inspection and maintenance, and

(3) any bridging of gullies and valleys in the ocean floor.

The increasing demand for petroleum hydrocarbons has led to the rapid development of pipeline technology for the Outer Continental Shelf - until recently, water depths of 200 feet were considered the upper limit for laying a pipeline of any practical length or diameter - a barge has already been constructed which can lay a 36 inch pipeline in 1000 feet of water.

Pipeline burial provides the best protection from the potential dangers from fishing gear an anchors.

New safety techniques - high and low pressure shut-off valves are routinely installed at all intervals along the line - these automatically shut-down the line in case of a rupture or unexpected high pressure.

Pipelines appear to be a major source of chronic pollution, although it is almost impossible to identify specific amounts of polluting oil released by them.

Major area of concern - continuing integrity of old pipe - pipelines can corrode both on the outside and the inside - at the present time, no satisfactory technique is available for identifying incipient pipeline failure as a guide to preventive maintenance over its lifetime. The pipeline must survive erosion by sand and corrosion by transported fluids and salt water - in addition, the system must survive mud slides, storm-generated wave motion, and anchor dragging.

Offshore pipeline systems include the pipe, flow, and pressure detectors (both onshore and on platforms), and associated safety values and shutdown system

A. Jurisdictional Conflicts

A number of problems of interdepartmental cooperation and coordination arise in connection with transporting oil and gas from the OCS by pipeline to a shore facility. The general problem appears to be that there are too many agencies, each concerned with its own particular aspect of the system, and often these various aspects are not well defined or separable.

Corp. of Engineers - concerned mainly with obstructions to navigation; this includes the pipelines from offshore platforms and artifical islands as well as to shoreline docking facilities.

Department of Interior - BLM has responsibility for granting of rights-of-way for pipeline purposes - pipelines are essentially carriers from the OCS to market. USGS has authority to grant permits for operational, or gathering lines.

DOT, Materials Transportation Bureau, has the responsibility for promulgating and enforcing safety regulations for the transportation of gases and hazardous liquid by pipeline - specifies the technical specifications for design, installation and operation of pipelines; shares jurisdiction with DOI over safety-related aspects of design, construction, operation, and maintenance of offshore pipelines, both on State lands beneath navigable waters and on the Outer Continental Shelf.

B. Design Problems

Serious problem - effect of wave-induced pressures and forces on the sediments around pipelines - waves may produce areal disturbances as well as local effects around pipelines.

Design of anchors presents significant problems - usually, a trial and error solution for anchor spacing and depth results.

Design and performance standards for offshore pipelines need to be improved. Automated, through-the-pipe equipment capable of identifying weak points in pipelines would facilitate preventive maintenance.

Need to be deployed - automated mass-flow monitoring equipment on pipelines. These can indicate major pipeline leaks and reduce the quantity of oil introduced into the water.

Study should be made of the feasibility of using the new anchor system developed by the Navy on ships that tend to be involved in anchor-dragging incidents.

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